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A THESIS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Systematic Study of Calaphidinae *s.l.* (Hemiptera: Aphididae) in the Korean Peninsula: Cryptic Diversity Identification and Phylogenetic Reconstruction

한반도산 참알락진딧물아과(노린재목: 진딧물과)의
계통분류학적 연구

By
Yerim Lee

ENTOMOLOGY PROGRAM
DEPARTMENT OF AGRICULTURAL BIOTECHNOLOGY

Seoul National University
August 2017

Systematic Study of Calaphidinae *s.l.* (Hemiptera: Aphididae) in the Korean Peninsula: Cryptic Diversity Identification and Phylogenetic Reconstruction

UNDER THE DIRECTION OF ADVISER SEUNGHWAN LEE
SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL
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ABSTRACT

Systematic Study of Calaphidinae *s.l.* (Hemiptera: Aphididae) in the Korean Peninsula: Cryptic Diversity Identification and Phylogenetic Reconstruction

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The subfamily Calaphidinae *s.l.* were investigated on three subjects: i) taxonomic review of the Korean Calaphidinae including two closely related subfamilies (Phyllaphidinae and Saltusaphidinae), ii) identifying cryptic diversity of the subfamily Calaphidinae *s.s.* based on DNA barcoding and iii) molecular phylogeny and evolutionary hypothesis of the subfamily Calaphidinae *s.l.*

In the first part, Calaphidinae and two closely related subfamilies (Phyllaphidinae and Saltusaphidinae) were reviewed in the Korean peninsula, comprising 89 species of 33 genera. In this study, 16 new species and 18 unrecorded species were newly recognized. In addition, 1 revived species, 4 misidentified, and 2 synonymized species were confirmed.

In the second part, cryptic diversity in the subfamily Calaphidinae *s.s.* were investigated based on 899 *cytochrome c oxidase I* (*COI*) sequences from 115 morphospecies. A total of 15 cryptic species was identified from 12 morphospecies as well as 3 morphologically distinct species pairs that shared DNA barcoding.

The third part was testing a monophyly of the subfamily Calaphidinae *s.l.* including sister group relationship and confirming the relationship among its components such as tribe and genera with reference to an evolutionary hypothesis of ancestral host plant relationship and host shift. The phylogenetic results demonstrated that Phyllaphidinae forms a basal node as the most primitive group of Calaphidinae *s.l.* and Calaphidinae *s.l.* is not a monophyly by including Saltusaphidinae.

Key words: aphids, cryptic species, new species, Phyllaphidinae, phylogeny, Saltusaphidinae

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PART I. Taxonomic review of Calaphidinae *s.l.* (Hemiptera: Aphididae) in the Korean peninsula

Abstract

The subfamily Calaphidinae *s.l.* (Hemiptera: Aphididae) was reviewed in the Korean peninsula. Prior to this study, 60 species of 28 genera have been reported in the Korean peninsula. In this study, a total of 89 species of 33 genera were recognized including 16 new species, 18 unrecorded, 1 revived species, 4 misidentified, and 2 synonymized species. Illustrations, diagnosis and descriptions for all known species including new species are provided. Keys to tribes, genera and species are also given.

Keywords: Korea, new records, new species, Phyllaphidinae, Saltusaphidinae

1.1. Introduction

1.1.1. General introduction

The subfamily Calaphidinae *s.l.* is the second-largest group in the family Aphididae (Hemiptera) with about 372 valid species within 63 genera (Table 1.1), mostly distributed in the Palearctic and Nearctic regions (Table 1.2) (Favret, 2017). Calaphidine aphids are monoecius on woody and herbaceous angiosperm plants (Table 1.3) with holocyclic lifecycle (Fig. 1.1). Calaphidinae *s.s.* is subdivided into two tribes, Calaphidini and Panaphidini (Nieto Nafria et al., 1997; Quednau 1999; Favret, 2017). All species in the tribe Calaphidini only occur on woody plants belonging to apploximately 6 plant families (Table 1.3). Betulaceae is the most dominant hosts, dwelling more than 90% of Calaphidini species (Blackman & Eastop, 2017). The most species rich group Panaphidini tend to have a wider range in their relation with host plants (Table 1.3). About 20 host plants have been known to serve as their hosts (Quednau, 1999; 2003; Blackman & Eastop, 2017).

In this study, additional taxonomic research on two closely related subfamilies, Phyllaphidinae and Saltusaphidinae, were performed on the basis of the most recent phylogenetic result of Aphididae (Novakova et al., 2013). Actually, testing traditional classifications including discussion of taxonomic relationship and its subdivision between those two subfamilies and Calaphidinae is one of the main issues in the Part III. Phyllaphidinae is one of the minor subfamilies among Aphidinae with about 23 species of 4 genera in the world (Favret, 2017). They have been recorded solely in the temperate region and have a monoecious holocyclic lifecycle on woody plants belonging to Fagaceae and Lauraceae (Table 1.3).

Sedge aphid, Saltusaphidinae only occurs on some sedges belonging to the family Poaceae (Table 1.3) with monoecius holocyclic lifecycle. This subfamiliy encompasses two tribes, Saltusaphidini and Thripsaphidini, with approximately 22 species of 7 genera and 36 species of 5 genera respectively (Table 1.1).

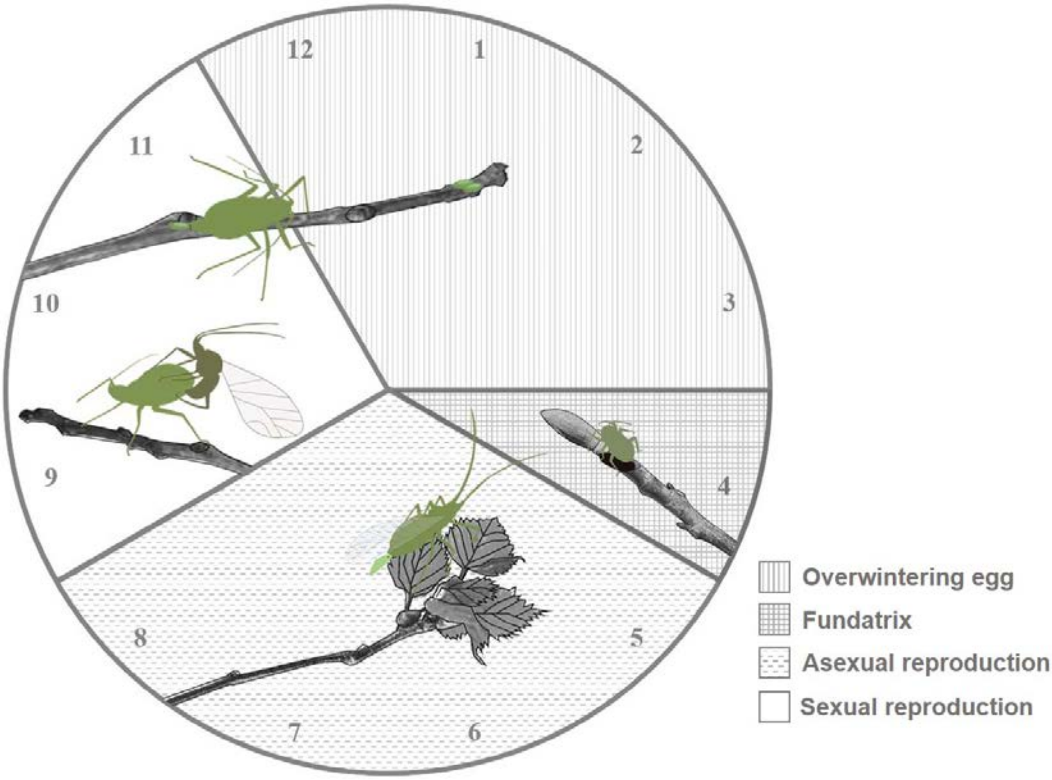

Fig. 1.1. Monoecious holocyclic lifecycle in Aphididae (Hemiptera)

1.1.2. Historical review

Classification of Calaphidinae *s.l.* has undergone considerable changes with a lot of controversy. In fact, aphidologists still hold different views on the actual taxa to be included in Calaphidinae and its subdivisions (Wojciechowski, 1992; Nieto Nafria et al., 1997; Quednau, 1999). Such taxonomic confusion is deeply involved historical disagreement over the classification and phylogenetic uncertainty of Aphididae. As Heie (1980) said, the number of aphid classifications is about the same as the number of aphid taxonomists. Compared to other sternorrhyncans, aphid morphology is extremely simple and has a lack of variation between higher taxonomic levels (Heie, 1987; Richads, 1965). Despite many attempts to construct a clear picture, aphid phylogeny still under much discussion in many relationships within the family group.

The subfamily name Calaphidinae was firstly used by Oestlund (1919) based on the type genus name *Calaphis* Walsh, 1863. Since Nieto Nafria et al. (1997) have corrected the name and it has been used up to date. The Callipterinae (Callipteriden) is the oldest known name of this group (Herrich-Schaeffer, 1857). With four species, Koch (1855) described the genus *Callipterus* and Herrich-Schaeffer (1857) used the first family group name Callipterinae based on the genus name (Table 1.4). At the time, Callipterinae was treated as one of the subfamilies under Drepanosiphidae.

Since Koch (1855) recorded the genus *Callipterus*, new genera and species improved the general classification of aphids. Mordvilko (1908) combined viviparous and oviparous aphids as a united family with three subfamilies

(Aphidinae, Pemphiginae, and Phylloxerinae). Subfamily Aphidinae included genus *Callipterus* and *Phyllaphis* under the tribe Callipterina (Table 1.4). Unlike Koch, Mordvilko placed genus *Drepanosiphum* in the distinct tribe Aphidina. Later, Van der Goot (1913) improved Mordvilko's classification by distinguishing viviparous aphids (Aphidinae) out of the family Aphididae with 11 tribes including Callipterina. In 1920, Baker proposed new classification with 4 distinguishing subfamilies: Eriosomatinae, Mindarinae, Hormaphidinae, and Aphidinae. In Baker's classification, Calaphidinae was treated as one of the subtribes under the tribe Callipterini within Aphidinae (Table 1.4).

The first valuable family group classification of the Calaphidinae was proposed by Börner based on the composition of setae on body parts (1952). Minor details of Börner's classification (1952) was modified later by Börner and Heinze (1957). In these schemes, Calaphidinae was treated as a family named Callaphididae with four subfamilies (Callaphidinae, Phyllaphidinae, Therioaphidinae, and Saltusaphidinae) (Table 1.4). Chaitophiridae and Aphididae was places as sister group of Callaphididae. The classification proposed by Börner (1952) was followed by Quednau (1954) with some minor changes. Quednau (1954) maintained basic frames of Börner's classification. However, he split up the system into tribes and subtribes (Table 1.4). Börner's system was followed by many aphidologists until 1964, although criticized by some authors.

Bodenheimer and Swirski (1957) merged Callaphididae and Chaitophoridae as a family Callaphididae again on the basis of Baker's classification (1920). In this classification, Callaphididae included two subfamilies Callaphidinae and Chaitophorinae. Callaphidinae was comprised of five tribes (Callipterini, Drepanosiphonini, Phyllaphidini, Saltusaphidini, and Therioaphidini). Shaposhnikov's classification (1964) was basically distinct from that of Börner's classification, especially the ordering of the families was almost opposite to Börner's idea. Callaphididae was placed between Thelaxidae and Chaitophoridae with two tribes (Callaphidini and Saltusaphidini) (Table 1.4).

Eastop (1966) treated aphids as only one family Aphididae with five subfamilies. In Eastop's classification, Calaphidinae is integrated into Drepanosiphini under the subfamily Drepanosiphinae which contained various genera (*Drepanosiphum*, *Euceraphis*, *Kallistaphis*, *Myzocallis*, *Phyllaphis*, *Rhinariaphis*, *Takecallis*, and *Tinocallis*) (Table 4). Later, Eastop (1977) subdivided five subfamilies into 12 subfamilies with more tribes. Drepanosiphinae became more split with 9 tribes (Drepanosiphini, Lizerini, Macropodaphidini, Mindarini, Neophyllaphidini, Neuquenaphidini, Phyllaphidini, Saltusaphidini, and Thelaxini). On the basis of Eastop's classification, Remaudière and Stroyan (1984) proposed 20 subfamilies of family Aphididae in which several alternations were reorganized: tribe Drepanosiphini, Lizerini, Macropodaphidini, Mindarini, and Phyllaphidini were elevated into subfamily level. However, they did not present any criteria for such changes.

Based on 18 external morphology and one ecological character, Heie (1987) proposed new system. Similar to Eastop, Heie viewed Calaphidinae as the subtribe under tribe Phyllaphidini within the family Drepanosiphidae. Heie considered that Calaphidinae is close to both subfamily Chaitophorinae and Drepanosiphinae. However, Wojciechowski's system (1992) is opposed to that of Heie's system. Wojciechowski proposed aphid phylogeny by using external body parts, internal organs and developmental features. According to Wojciechowski, Caalaphidinae is closely related to Aphidinae, although taxonomic level of Calaphidinae is similar to Heie's system. In the most of parts, there are lack of consensus between Heie (1984) and Wojciechowski (1992). Quednau and Remaudière (1994) also had different view on Calaphidinae. In their system, Calaphidinae were placed into Myzocallidinae within drepanosiphine aphid group (Mindarinae, Neophyllaphidinae, Israelaphidinae, Lizeriinae, Taiwanaphidinae, Parachaitophorinae, Pterastheniinae, Phyllaphidinae, Neuquenaphidinae, Macropodaphidinae, Drepanosiphinae, Chaitophorinae, Saltisaphidinae, and Myzocallidinae).

Quednau and Remaudière's system (1994) as well as an earlier classification by Remaudière and Stroyan (1984) were served as a foundation of the world catalogue of Aphididae (Remaudière & Remaudière, 1997). Remaudière and Remaudière (1997) established a basis of present classification system of Aphids. In this publication, calaphidine aphids are belong to Myzocallidinae with 2 tribes (Calaphidini and Myzocallidini) (Table 1.4). With minor modification by Quednau (1999), taxonomic status of Calaphidinae have become a current form. According to Quednau, Calaphidinae is divided into two tribes (Calaphidini and Panaphidini). Tribe Calaphidini is regarded as more primitive group and comprises two subtribes (Monaphidina and Calaphidina) with about 80 describes species. Compared to Calaphidini, Panaphidini group have much higher species diversity within two subdivided groups (Myzocallidina and Panaphidina) (Table 1.4). In the serial publications named ‘Atlas of the Drepanosiphine aphids of the world part I – III’ (Quednau, 1999; 2003; 2010), Calaphidinae is treated as the most recently derived group within drepanosiphine aphids (Mindarinae, Neophyllaphidinae, Lizeriinae, Pterastheniinae, Macropodaphidinae, Taiwanaphidinae, Spicaphidinae, Phyllaphidinae, Israelaphidinae, Saltusaphidinae, Drepanosiphinae, and Calaphidinae). In this paper, Chaitophorinae, Paracahitophorinae, and Tamalinae is excluded, althoguh Quednau (2010) leaves room for interpretation of grouping those subfamilies.

Opposed to Quednau’s view, Wieczorek et al. (2011) argued that drepanosiphine aphid group is too much subdivided especially on the level of subfamily. Based on the comparative study of aphid male genitalia, Wieczorek et al. (2011) proved that there is no conspicuous differences between Calaphidinae, Phyllaphidinae, and Saltusaphidinae. They also shown that Calaphidinae group is closely related with Aphidinae, Chaitophorinae, and Drepanosiphinae by having normal sized males without modified external genitalia.

As I reviewed the historical changes of the subfamily Calaphidinae, drow a clear picture is challenging as ever. Especially it is necessary to investigate the correct taxon boundaries of Calaphidinae (whether included into Calaphidinae or not) and the rank of its subdivisions (whether tribe or subfamily).

1.1.3. Historical review of Calaphidinae *s.l.* in the Korean peninsula

Historically, several studies have been conducted on Korean Calaphidinae *s.l.* by only a few authors. The earliest studies were conducted solely by Paik. Since 1965, Paik published several papers on the Korean aphid fauna. Paik recorded 15 Calaphidinae species and 1 Phyllaphidinae species under subfamily Callipterinae Herrich-Schaeffer, 1857 without tribal subdivisions (Table 1.5). In his classification, Chaitophorinae was integrated with Calaphidinae *s.l.* Among his publications, the most well-known work is vol.13 of Illustrated Encyclopedia of fauna and flora of Korea which deals more than 300 species of seven subfamilies in Korea (Paik, 1972). In this publication, 34 species of 17 genera are described within subfamily Drepanosiphinae which included Calaphidinae, Drepanosiphinae, Phyllaphidinae, and Saltusaphidinae (Paik, 1972). Later, Quednau (1979) reviewed Korean Calaphidinae from Northern part of Korean peninsula (Table 1.5). In this study, Quednau (1979) recorded 29 species of 16 genera including 5 new species and 9 new records (Table 1.5). More recent years, Quednau and Lee (2001) studied on Calaphidinae in the southern part of Korean peninsula. This study dealt with Calaphidinae, Drepanosiphinae, Phyllaphidinae, and Saltusaphidinae with description of one new species (Table 1.5). Through this study, 13 Calaphidinae species (seneu Quednau), 2 Phyllaphdinae species and 1 Saltusaphidinae species were newly recorded (Table 1.5). In the introduction part of this study, Quednau said that later study will be conducted in part II. However, unfortunately, there have been no additional studies on Calaphidinae *s.l.* in the Korean peninsula until now.

In this study, a total of 89 species of Calaphidinae *s.l.* were reviwed in the

Korean peninsula (Table 1.6). As a results, 16 new species, 17 unrecorded species, 1 revived species, 4 misidentified species, and 2 synonymized species were newly recognized.

Table 1.1. Number of described species of Calaphidinae *s.l.* in the world (Favret, 2017)

Subfamily	Tribes	Subtribes	Number of genera	Number of species
Calaphidinae	Calaphidini	Monaphidina	3	4
		Calaphidina	14	75
	Panaphidini	Myzocallidina	14	149
		Panaphidina	31	144
Phyllaphidinae	-	-	4	19
Saltusaphidinae	Saltusaphidini	-	7	22
	Thripsaphidini	-	5	36
		Total	**78**	**449**

Table 1.2. Number of species of Calaphidinae *s.l.* in each biogeographic region

Biogeographic regions	Calaphidinae				Phyllaphidinae	Saltusaphidinae	
	Calaphidini		Panaphidini		-	Saltusaphidini	Thripsaphidini
	Monaphidina	Calaphidina	Myzocallidina	Panaphidina	-	-	-
Palearctic	3	47	67	109	6	14	21
Oriental	-	13	13	34	-	-	1
Nearctic	1	30	64	34	10	9	15
Australian	-	3	5	6	1	-	1
Ethiopian	-	1	3	6	-	1	-
Neotropical	1	-	30	7	2	-	1

Table 1.3. Recorded host plant list of Calaphidinae *s.l.* in the world (Blackman & Eastop, 2017)

	Plant families	Genera	Calaphidinae				Phyllaphidinae	Saltusaphidinae	
			Calaphidini		Panaphidini		-	Saltusaphidini	Thripsaphidini
			Monaphidina	Calaphidina	Myzocallidina	Panaphidina	-	-	-
Woody angiosperms	Anacardiaceae	*Rhus*				O			
	Betulaceae	*Alnus*	O	O		O			
		Betula	O	O					
		Carpinus			O	O			
		Corylus			O	O			
		Ostrya				O			
	Cannabaceae	*Celtis*				O			
	Euphorbiaceae	*Aleurites*				O			
	Fabaceae	*Castanospermum*		O		O			
		Dalbergia				O			
		Peltophorum				O			
		Sophora				O			
		Robinia				O			
	Fagaceae	*Castanea*			O				
		Fagus	O	O		O	O		
		Lithocarpus			O				
		Quercus		O	O		O		
	Juglandaceae	*Carya*				O			
		Juglans				O			
		Pterocarya				O			
	Lauraceae	*Lindera*					O		
		Machilus					O		
	Lythraceae	*Duabanga*				O			
		Lagerstroemia				O			
		Lawsonia				O			
	Magnoliaceae	*Magnolia*		O		O			
	Malvaceae	*Tilia*				O			
	Myricaceae	*Comptonia*		O					
		Myrica		O	O				
	Phyllanthaceae	*Phyllanthus*				O			
	Rosaceae	*Prunus*		O		O			
	Rutaceae	*Ptelea*				O			
	Sapindaceae	*Aesculus*				O			
		Sapindus				O			
	Ulumaceae	*Hemiptelea*				O			
		Ulmus				O			
		Zelkova				O			

Table 1.3. (continued)

	Plant families	Genera	Calaphidinae				Phyllaphidinae	Saltusaphidinae	
			Calaphidini		Panaphidini		-	Saltusaphidini	Thripsaphidini
			Monaphidina	Calaphidina	Myzocallidina	Panaphidina	-	-	-
					o				
Herbaceus angiosperms	Fabaceae	*Alhagi*				o			
		Astragalus				o			
		Calycotome				o			
		Caragana				o			
		Coronilla				o			
		Cytisus				o			
		Dorycnium				o			
		Genista				o			
		Lembotropis				o			
		Lotus				o			
		Medicago				o			
		Melilotus				o			
		Ononis				o			
		Onobrychis				o			
		Trifolium				o			
		Trigonella				o			
	Poaceae	*Arundinariae*				o			
		Arundo				o			
		Bambusa				o			
		Carex						o	o
		Cyperus						o	
		Dendrocalamus				o			
		Juncus						o	
		Phyllostachys				o			
		Pleioblastus				o			
		Poa						o	
		Sasa				o			
		Uncinia							o
		Yushania				o			

Table 1.4. Selected alternative classification of Calaphidinae *s.l.*

Herrich-Shaeffer, 1857	**Mordvilko, 1908**	**Baker, 1920**	**Börner, 1952**	**Quednau, 1954**	**Börner & Heinze 1957**
Drepanosiphiden	Aphididae	Aphidinae	Callaphididae	Callaphididae	Callaphididae
- Callipteriden	- Aphidinae	- Callipterini	- Phyllaphidinae	- Phyllaphidinae	- Phyllaphidinae
- Phyllaphiden	- Aphidina	- Phyllaphidina	- Symydobiini	- Phyllaphidini	- Symydobiini
	- *Drepanosiphum*	- Callipterina	- Phyllaphidini	- Symydobiina	- Phyllaphidini
	- *Chaitophorus*	- Saltusaphidina	- Phyllaphidina	- Phyllaphidina	- Drepanosiphonini
	- Callipterina	- Drepanosiphina	- Callaphidinae	- Cryptuaphidina	- Callaphidinae
	- *Callipterus*	- Monaphidina	- Therioaphidinae	- Drepanosiphonini	- Callaphidini
	- *Phyllaphis*	- Chaitophorina	- Saltusaphidinae	- Callaphidinae	- Myzocallidini
		- Pterocommina		- Callaphidini	- Therioaphidinae
		- Fullawayna		- Myzocallidini	- Saltusaphidinae
				- Myzocallidina	- Thripsaphidini
				- Eucallipterina	- Iziphyini
				- Therioaphidinae	
				- Saltusaphidinae	
				- Thripsaphidini	
				- Thripsaphidina	
				- Trichocallidina	
				- Iziphyini	

Table 1.4. (continued)

Bodenheimer & Swirski, 1957	Shaposnikov, 1964	Eastop, 1966	Eastop, 1977	Heie, 1987	Wojciechowski, 1992
Callaphididae	Callaphididae	Aphididae	Aphididae	Drepanosiphidae	Drepanosiphidae
- Chitophorinae	- Callaphidini	- Drepanosiphinae	- Drepanosiphinae	- Dreapnosiphinae	- Drepanosiphinae
- Callaphidinae	- Saltusaphidini	- Drepanosiphini	- Drepanosiphini	- Drepanosiphini	- Calaphidinae
- Callaphidini	- Macropodaphidina	- Drepanosiphum	- Lizeriini	- Phyllaphidini	- Chaitophorinae
- Drepanosiphini	- Saltusaphidina	- Euceraphis	- Macropodaphidini	- Phyllaphidina	
- Phyllaphidini		- Kallistaphis	- Mindarini	- Callaphidina	
- Saltusaphidini		- Myzocallis	- Neophyllaphidini	- Therioaphidina	
- Therioaphidini		- Phyllaphis	- Neuquenaphidini	- Macropodaphidini	
		- Rhinariaphis	- Phyllaphidini	- Saltusaphidini	
		- Takecallis	- Saltusaphidini		
			- Thelaxini		

Table 1.4. (continued)

Remaurdier et al., 1997	Nieto Nafría et al., 1997	Quednau, 1999
Myzocallidinae	Calaphidinae	Calaphidinae
- Calaphidini	- Calaphidini	- Calaphidini
- Myzocallidini	- Panaphidini	- Monaphidina
Phyllaphidinae	Phyllaphidinae	- Calaphidina
Saltusaphidinae	Saltusaphidinae	- Panaphidini
		- Myzocallidina
		- Panaphidina
		Phyllaphidinae
		Saltusaphidinae
		- Thripsaphidini
		- Saltusaphidini

Table 1.5. Historical review of Korean Calaphidinae *s.l.*

Year	Author	Subfamilies	Species	No. of species
1965	Paik	Calaphidinae	*Betacallis alnicolens* Matsumura, 1919 *Calaphis magnolia* Essig & Kuwana, 1918 *Symydobius kabae* (Matsumura, 1917) *Tuberculatus quercicola* (Matsumura, 1917) *Tuberculatus capitatus* (Essig & Kuwana, 1918) *Dasyaphis rhusae* (Shinji, 1922) *Neochromaphis carpinicola* (Takahashi, 1921) *Pseudochromaphis coreana* Paik, 1965* *Pterocallis alnijaponicae* (Matsumura, 1919) *Pterocallis nigrostriata* (Shinji, 1941) *Sarucallis kahawaluokalani* (Kirkaldy, 1907) *Takecallis arundicolens* (Clark, 1903) *Tiliaphis shinae* Shinji, 1924 *Tinocallis zelkowae* (Takahashi, 1919)	**14**
		Phyllaphidinae	*Diphyllaphis konarae* (Shinji, 1924)	**1**
1972	Paik	Calaphidinae	*Symydobius oblongus* (von Heyden, 1837)^ *Tuberculatus japonicus* Higuchi, 1969 *Tuberculatus stigmatus* (Matsumura, 1917) *Tuberculatus kuricola* (Matsumura, 1917) *Tuberculatus kashiwae* (Matsumura, 1917)^ *Tuberculatus querciformosanus* (Takahashi, 1921) *Tuberculatus yokoyamai* (Takahashi, 1923) *Chromocallis nirecola* (Shinji, 1933) *Mesocallis sawashibae* (Matsumura, 1917) *Neochromaphis coryli* (Takahashi, 1921) *Shivaphis celti* Das, 1918 *Takecallis arundinaliae* (Essig, 1917) *Takecallis sasae* (Matsumura, 1917)^ *Tinocallis saltans* (Nevsky, 1929) *Tinocallis ulmicola* (Matsumura, 1919) *Tinocallis ulmiparvifoliae* Matsumura, 1919	**16**
		Phyllaphidinae	*Diphyllaphis quercus* (Takahashi, 1960)	**1**
		Saltusaphidinae	*Subsaltusaphis virginica* (Baker, 1917)	**1**
1979	Quednau	Calaphidinae	*Betulaphis japonica* Takahashi, 1961+ *Calaphis similis* Quednau, 1979* *Clethrobius comes* (Walker, 1848) *Tuberculatus indicus* Ghosh, 1972 *Tuberculatus higuchii* Hille Ris Lambers, 1974 *Tuberculatus paiki* Hille Ris Lambers, 1974 *Tuberculatus paranaracola* Hille Ris Lambers, 1974 *Mesocallis corylicola* (Higuchi, 1972) *Pterocallis heterophylla* Quednau, 1979* *Shivaphis szelegiewiczi* Quednau, 1979* *Tiliaphis coreana* Quednau, 1979* *Tiliaphis pseudoshinae* Quednau, 1979*	**12**
2000	Quednau and Lee	Calaphidinae	*Callipterinela calliptera* (Hartig, 1841) *Euceraphis coerulescens* Pashtshenko, 1984 *Euceraphis punctipennis* (Zetterstedt, 1828) *Symydobius minutus* Quednau & Shaposhnikov, 1988 *Tuberculatus fuscotuberculatus* Zhang et al., 1990 *Tuberculatus pappus* Zhang et al., 1990+ *Shivaphis catalpinari* Quednau & Remaudiére, 1985 *Shivaphis tilisucta* (Zhang, 1990) *Takecalis taiwana* (Takahashi, 1926) *Therioaphis subalba* Börner, 1949 *Therioaphis trifolii* (Monell, 1882) *Tiliaphis shinjii* Higuchi, 1972	**12**
		Phyllaphidinae	*Phyllaphis fagi* (Linnaeus, 1761)^	**1**
		Saltusaphidinae	*Saltusaphis tuberculate* Quednau & Lee, 2001* *Thripsaphis ballii caespilosae* Ossiannilsson, 1954	**2**
			Total	**60**

* New species firstly described in Korea; ^ Misidentified species; + Synonymized species

Table 1.6. Check list of Korean Calaphidinae *s.l.*

Subfamilies	Tribes	Subtribes	Genera	Subgenera	Species	First record in Korea
Calaphidinae	Calaphidini	Calaphidina	*Betacallis*		*alnicolens* Matsumura, 1919	Quednau, 1979
					trilineata **sp. nov.**	**This study**
			Betulaphis		*quadrituberculats* (Kaltenbach, 1843)	**This study**
			Boernerina		*occidentalis* Hille Ris Lambers & Hottes, 1962	**This study**
			Calaphis		*magnolia* Essig & Kuwana, 1918	Paik, 1965
					similis Quednau, 1979	Quednau, 1979
			Callipterinella		*calliptera* (Hartig, 1841)	Quednau & Lee, 2001
					tuberculata (von Heyden, 1837)	**This study**
			Clethrobius		*comes* (Walker, 1848)	Quednau, 1979
			Euceraphis		*caerulescens* Pashtshenko, 1984	Quednau & Lee, 2001
					nigra **sp. nov.**	**This study**
					papyrifericola Blackman, 2002	**This study**
					punctipennis (Zetterstedt, 1828)	Quednau & Lee, 2001
			Neobetulaphis		*pusilla* Basu, 1964	**This study**
			Symydobius	*Symydobius*	*minutus* Quednau & Shaposhnikov, 1988	Quednau & Lee, 2001
				Yezocallis	*kabae* (Matsumura, 1917)	Paik, 1965
Calaphidinae	Calaphidini	Monaphidina	*Monaphis*		*antennata* Walker, 1870	**This study**
Calaphidinae	Panaphidini	Myzocallidina	*Tuberculatus*	*Acanthocallis*	*alienae* **sp. nov.**	**This study**
					macrotuberculatus (Essig & Kuwana, 1918)	**This study**
					quercicola (Matsumura, 1917)	Paik, 1965
				Acanthotuberculatus	*acutissimae* **sp. nov.**	**This study**
					indicus Ghosh, 1972	Quednau, 1979
					japonicus Higuchi, 1969	Paik, 1972
				Arakawana	*orientalis* **stat. rev.**	**This study**
					stigmatus (Matsumura, 1917)	Paik, 1972
				Nippocallis	*hirta* **sp. nov.**	**This study**
					kuricola (Matsumura, 1917)	Paik, 1972
				Orientuberculoides	*alba* **sp. nov.**	**This study**

Table 1.6. (continued)

Subfamilies	Tribes	Subtribes	Genera	Subgenera	Species	First record in Korea
Calaphidinae	Panaphidini	Myzocallidina	*Tuberculatus*	*Orientuberculoides*	*capitatus* (Essig & Kuwana, 1918)	Paik, 1965
					fangi (Tseng & Tao, 1938)	Quednau & Lee, 2001
					fuscotuberculatus Zhang, Zhang & Zhong, 1990	Quednau & Lee, 2001
					higuchii Hille Ris Lambers, 1974	Quednau, 1979
					lambersi **sp. nov.**	**This study**
					paiki Hille Ris Lambers, 1974	Quednau, 1979
					paranaracola Hille Ris Lambers, 1974	Quednau, 1979
					querciformosanus (Takahashi, 1921)	Paik, 1972
					richardsi **sp. nov.**	**This study**
					silvae **sp. nov.**	**This study**
					yaoi **sp. nov.**	**This study**
					yokoyamai (Takahashi, 1923)	Paik, 1972
Calaphidinae	Panaphidini	Panaphidina	*Chromaphis*		*juglandicola* (Kaltenbach, 1843)	**This study**
			Chromocallis		*nirecola* (Shinji, 1933)	Paik, 1972
			Dasyaphis		*rhusae* (Shinji, 1922)	Paik, 1965
			Mesocallis	*Mesocallis*	*ptelea* Matsumura, 1919	**This study**
					sawashibae (Matsumura, 1917)	Paik, 1972
					carpinicola **sp. nov.**	**This study**
				Paratinocallis	*corylicola* (Higuchi, 1972)	Quednau, 1979
					occultus **sp. nov.**	**This study**
			Monelliopsis		*caryae* (Monell, 1879)	**This study**
			Neochromaphis		*carpinicola* (Takahashi, 1921)	Paik, 1965
					coryli Takahashi, 1961	Paik, 1972
			Panaphis		*juglandis* (Goeze, 1778)	**This study**
			Pseudochromaphis		*coreana* Paik, 1965	Paik, 1965
			Pterocallis	*Pterocallis*	*heterophylla* Quednau, 1979	Quednau, 1979
				Recticallis	*alnijaponicae* (Matsumura, 1919)	Paik, 1965
					nigrostriata (Shinji, 1941)	Paik, 1965

Table 1.6. (continued)

Subfamilies	Tribes	Subtribes	Genera	Subgenera	Species	First record in Korea
Calaphidinae	Panaphidini	Panaphidina	*Sarucallis*		*kahawaluokalani* (Kirkaldy, 1907)	Paik, 1965
			Shivaphis	*Shivaphis*	*catalpinari* Quednau & Remaudiére, 1985	Quednau & Lee, 2001
					celti Das, 1918	Paik, 1972
			Shivaphis	*Sinishivaphis*	*sinensis* **sp. nov.**	**This study**
					szelegiewiczi Quednau, 1979	Quednau, 1979
					tilisucta (Zhang, 1990)	Quednau & Lee, 2001
			Takecallis		*arundicolens* (Clarke, 1903)	Paik, 1965
					arundinariae (Essig, 1917)	Paik, 1972
					longiantennata **sp. nov.**	**This study**
					obscura **sp. nov.**	**This study**
					taiwana (Takahashi, 1926)	Quednau & Lee, 2001
			Therioaphis	*Pterocallidium*	*subalba* Börner, 1949	Quednau & Lee, 2001
					trifolii (Monell, 1882)	Quednau & Lee, 2001
			Tiliaphis		*coreana* Quednau, 1979	Quednau, 1979
					pseudoshinae Quednau, 1979	Quednau, 1979
					shinae Shinji, 1924	Paik, 1965
					shinjii Higuchi, 1972	Quednau & Lee, 2001
			Tinocallis	*Sappocallis*	*saltans* (Nevsky, 1929)	Paik, 1972
					takachihoensis Higuchi, 1972	**This study**
					ulmicola (Matsumura, 1919)	Quednau, 1979
				Tinocallis	*latifoliae* **sp. nov.**	**This study**
					mushensis (Takahashi, 1925)	**This study**
					ulmiparvifoliae Matsumura, 1919	Paik, 1972
					viridis (Takahashi, 1929)	**This study**
					zelkowae (Takahashi, 1919)	Paik, 1965
Phyllaphidinae			*Diphyllaphis*	*Diphyllaphis*	*konarae* (Shinji, 1924)	Paik, 1965
				Nymphaphis	*quercus* (Takahashi, 1960)	Paik, 1972
			Machilaphis		*machili* (Takahashi, 1928)	**This study**

Table 1.6. (continued)

Subfamilies	Tribes	Subtribes	Genera	Subgenera	Species	First record in Korea
Phyllaphidinae			*Phyllaphis*		*fagifoliae* Takahashi, 1919	**This study**
Saltusaphidinae	Saltusaphidini		*Saltusaphis*		*tuberculata* Quednau & Lee, 2001	Quednau & Lee, 2001
	Thripsaphidini		*Allaphis*		*ossiannilssoni* (Hille Ris Lambers, 1952)	**This study**
			Subsaltusaphis		*virginica* (Baker, 1917)	Paik, 1972
			Thripsaphis		*ballii caespilosae* Ossiannilsson, 1954	Quednau & Lee, 2001

1.2. Materials and Methods

1.2.1. Taxon sampling

Material examined for the present study is based on collections in the following institutions: College of Agriculture and Life Sciences, Seoul National University, Seoul, South Korea (CALS SNU), Canadian National Collection (CNC), Institute of Entomology, Czech Academy of Science, Ceske Budejovice, Czech (IECAS), and National Academy of Agricultural Sciences, Jeonju, South Korea (NAAS). The collections were performed mostly with naked eye and yellow pan traps.

1.2.2. Specimen preparation and examination

Aphid samples were collected in 95% ethanol and preserved at -10°C. For identification and description, speciens were mounted with Canada balsam according to the modified methods of Blackman and Eastop (2000) and Martin (1983) as following 1-7 steps.

(1) Gently puncture lateral abdominal tergum of specimens and transfer them into 0.6ml tubes.

(2) Boil in 10% potassium hydroxide (KOH) solution for 10-30 min.

(3) Remove KOH solution and wash the specimens free of KOH using 5-6 changes of distilled water, leaving them to soak for 20 min

(4) Pipette off distilled water, add glacial acetic acid (GAA) and remove, repeat these step for 3 times. Each step needs 5 min.

(5) Dcant GAA, add clove oil and leave at least 20 min.

(6) Transfer 1 aphid to a drop of Canada balsam and Xylene mixture (9:1) on a slide glass and arrange the appendages and gently cover with micro cover glass.

(7) Dry the slide horizontally in an oven at 50°C for about 1 month.

Specimens were examined under a microscope, and illustrations for each species were taken by a digital camera (Infinity 3, Lumenera Co., Canada) attatched to a microscope (Leica 400B, Leica Misrosystem, Germany) at a resolution of 600 dpi. Measurements for each specimen are taken from the digital images by using image analyses software (Active measure ver. 3.0.3., Mitani Co. Ltd, Japan).

1.2.3. Glossary: Terms used in aphid morphology

The glossary of aphids are explained in figures 3-9. Abbreviations used in this study are listed in tables 1.7 and 1.8.

Table 1.7. Abbreviations used in this study

Body parts	Characters	Abbreviations
	Antennal segment I	Ant.I
	Antennal segment II	Ant.II
	Antennal segment III	Ant.II
Antenna	Antennal segment IV	Ant.IV
	Antennal segment V	Ant.V
	Base of Antennal segment VI	Ant.VIb
	Processus terminalis	PT
	Bsal diameter of antenna III	BDAnt.III
Rostrum	Ultimate rostral segment	URS
	Second segement of hind tarsi	2HT
Appendages	Hind femur	HFM
	Hind tibia	HTB
Wing veins	Costa	Co
	Cubitus	Cu
	Media	M
	Pterostigma	Pts
	Radial sector	Rs
etc	Siphunculi	SIPH

Table 1.8. Abbreviation for localities used in this study

Localities		Abbreviation
South Korea	Chungcheongbuk-do	CB
	Chungcheongnam-do	CN
	Gangwon-do	GW
	Gyeonggi-do	GG
	Gyeongsangbuk-do	GB
	Gyeongsangnam-do	GN
	Jeollabuk-do	JB
	Jeollanam-do	JN
	Jeju-do	JJ
North Korea	Chnagang-do	CG
	Hamgyeongbuk-do	HB
	Hamgyeongnam-do	HN
	Hwanghaebuk-do	HB
	Hwanghaenam-do	HN
	Pyeonganbuk-do	PB
	Pyeongannam-do	PN
	Yanggang-do	YG
	Jagang-do	JG

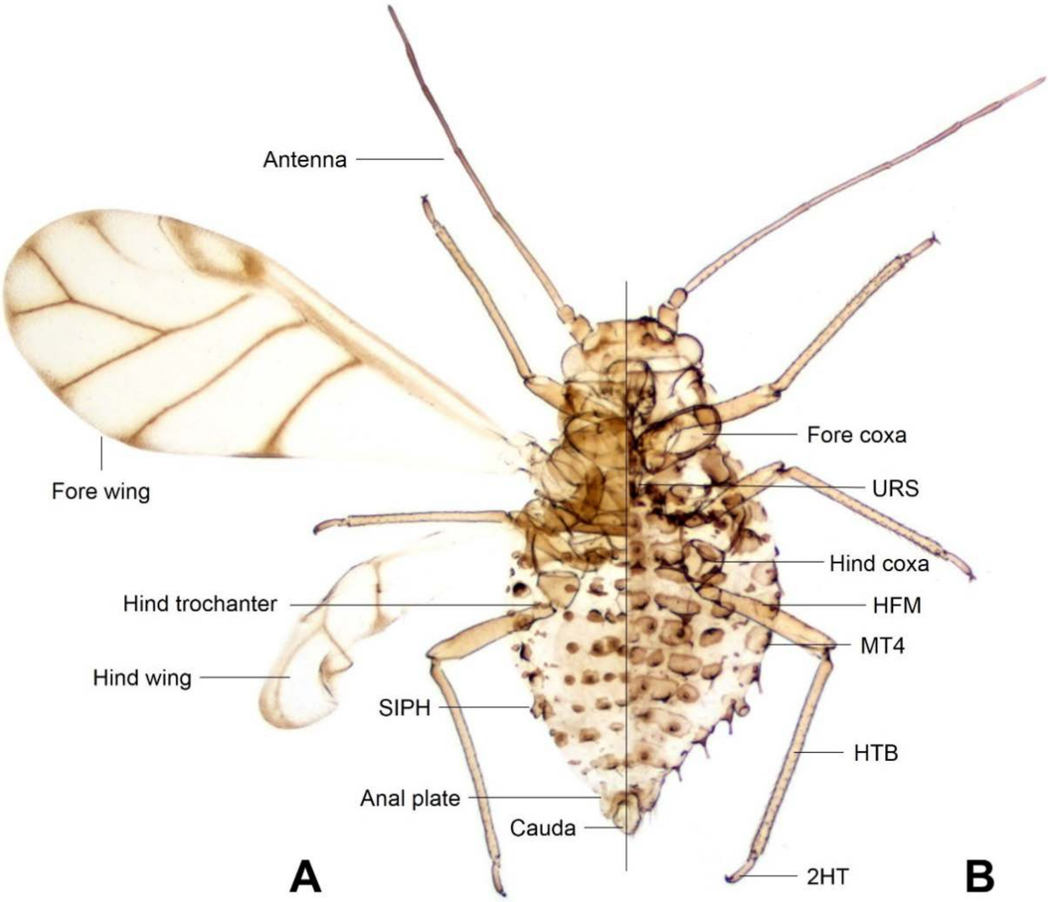

Fig. 1.2. Body (A, alate viviparous female; B, apterous viviparous female of *Therioaphis trifolii* (Monell, 1882))

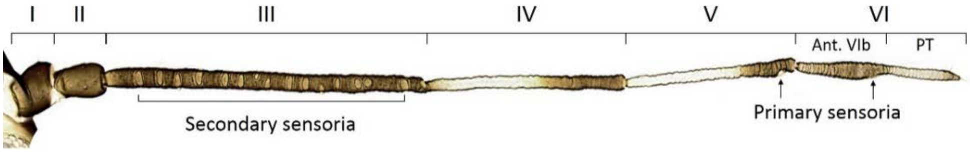

Fig. 1.3. Antenna (alate viviparous female of *Mesocallis pteleae* Matsumura, 1919)

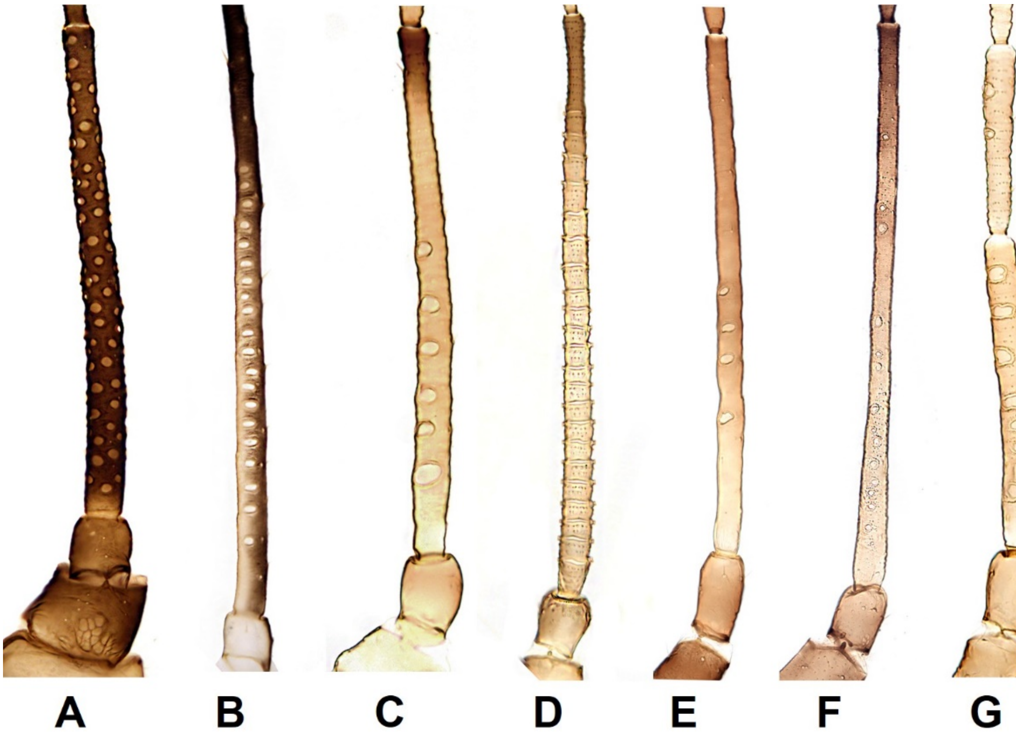

Fig. 1.4. Various shapes and arrangement of secondary rhinaria on Ant.III between groups (A, Monaphidina; B, Calaphidina; C, Myzocallidina; D, Panaphidina; E, Phyllaphidinae; F, Saltusaphidini; G, Thripsaphidini).

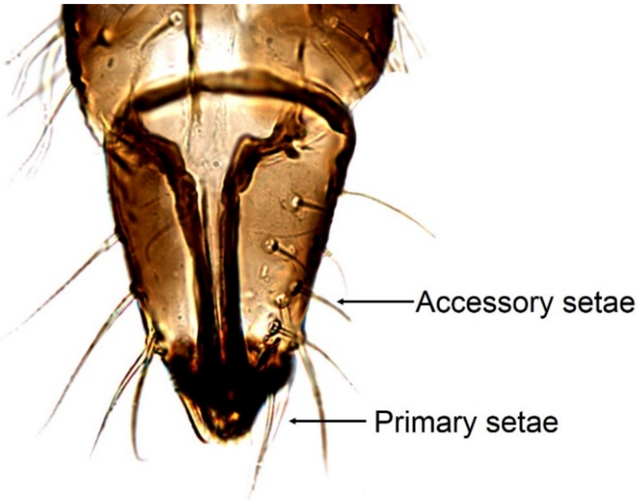

Fig. 1.5. Setae on URS (*Clethrobius comes* (Walker, 1848))

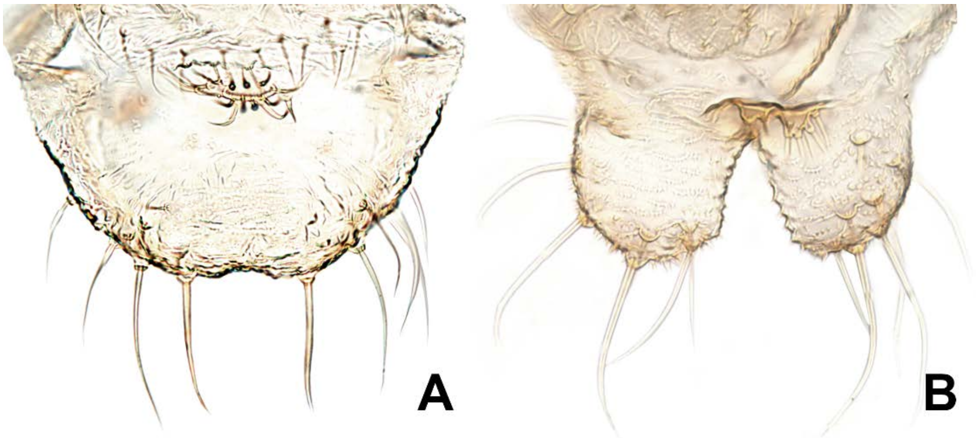

Fig. 1.6. Anal plate (A, rounded analplate of *Euceraphis papyrfericola* Blackman, 2002; B, bilobated analplate of *Neochromaphis carpinicola* Takahashi, 1921)

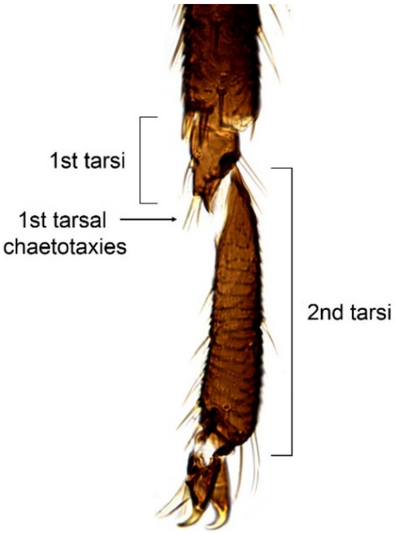

Fig. 1.7. Hind tarsi (*Euceraphis papyrifericola* Blackman, 2002)

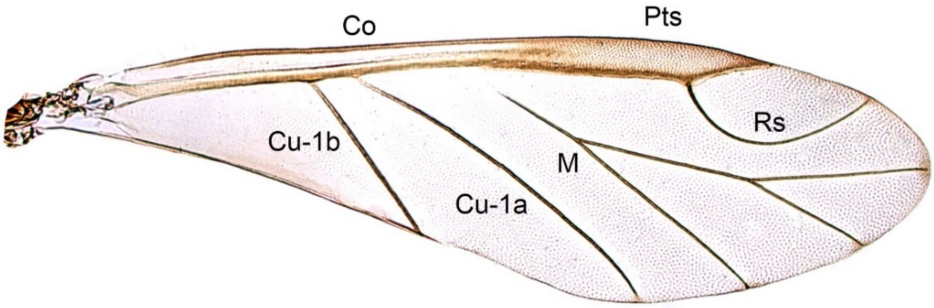

Fig. 1.8. Fore wing (*Clethrobius comes* (Walker, 1848))

1.3. Systematic accounts

Order **HEMIPTERA** Linnaeus, 1785

Suborder **STERNORRHYNCHA** Grimaldi and Engel, 2005

Superfamily **APHIDOIDEA** Latreille, 1802

Family **APHIDIDAE** Latreille, 1802

Subfamily **CALAPHIDINAE** Oestlund, 1919

1.3.1. Subfamily **Calaphidinae Oestlund, 1919** **참알락진딧물아과**

Type genus: *Calaphis* Walsh, 1863: 297, 301.

The subfamily Calaphidinae comprising approximately 372 species worldwide (Favret, 2017), is characterized by short cylindrical shaped SIPH (about 0.07 times body length), marginal tubercles often well developed on pronotum and abdominal tergites. Base of URS usually with a well sclerotized wishbone-shaped stiffening. Accessory rhinaria on Ant.VIb never scattered. Viviparous female apterous and alate or only alate. Mostly distributed in northern temperate region.

Key to the tribes and subtribes of Calaphidinae (Fig. 1.9)

1. Head vertex with 3 pairs of anterior discal setae; Antenna imbricated; fore coxa never enlarged; Rs well developed; Abdominal dorsum without finger like processes or elevations .... **2. Calaphidini**

- Head vertex with 2 pairs of anterior discal setae; Antenna spiculose; fore coxa often moderate to enlarged; Rs often weakly developed or absent; Abdominal dorsum often with finger like processes or elevations..................................... .... **3. Panaphidini**

2. Primary rhinaria nude; secondary rhinaria irregulary scattered over whole surface of Ant.III (Fig. 1.4A); Spinal and preural body setae numerous, extremely small or almost invisible... **Monaphidina**

- Primary rhinaria mostly ciliate, rarely nude; secondary rhinaria arranged in a single row and not covering whole surface of Ant.III (Fig. 1.4B); Spinal and pleural body setae in various arrangement, mostly conspicuous. **Calaphidina**

3. Secondary rhinaria round shaped; fore coxa little or moderately enlarged .... **Myzocallidina**

- Secondary rhinaria elliptical, narrow elliptical or even slit-like shape; fore coxa often greatly enlarged.. **Panaphidina**

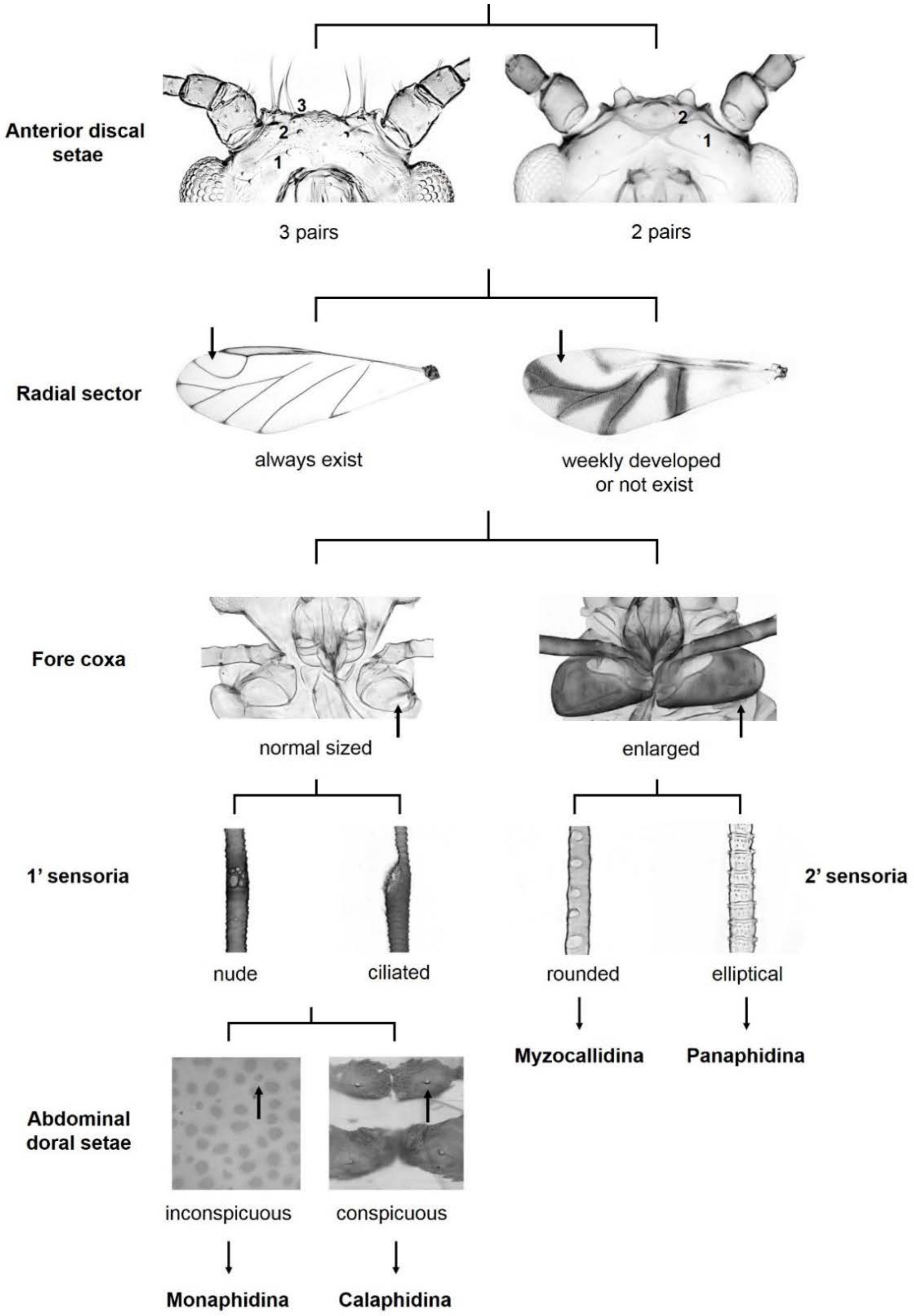

Fig. 1.9. Pictorial key to the subtribes of Calaphidinae

Tribe Calaphidini Oestlund, 1919 참알락진딧물족

Subtribe Calaphidina Oestlund, 1919 참알락진딧물아족

Type genus: *Calaphis* Walsh, 1863: 297, 301.

Key to the genera of subtribe Calaphidina in Korea

1. Head with a dark transverse band on venter..................................... ***Betacallis***

- Head without a dark transverse band **2**

2. Head with distinct triangular processes... **3**

- Head without distinct triangular processes **4**

3. Abdominal margin with saw tooth shaped asymetric tubercles, cauda knob rounded... ***Boernerina***

- Abdominal margin without saw tooth shaped tubercles, cauda knob elongated .... ***Neobetulaphis***

4. Cauda broadly rounded or tongue like triangular shaped................................ **5**

- Cauda knobbed.. **6**

5. Whole body covered with long and fine hairs, abdominal margin with wax gland pore.. ***Symydobius***

- Body surface smooth with sparse hairs, wax gland pore not developed............ .... ***Betulaphis***

6. PT shorter than Ant.VIb, anal plate broadly rounded..................................... **7**

- PT longer than Ant.VIb, anal plate bilobed... **8**

7. Abdominal margin with about 12-24 hairs, abdominal tergite VIII with 14-16 hairs .... ***Clethrobius***

- Abdominal margin with about 2-6 hairs, abdominal tergite VIII with 7-8 hairs.
.... ***Euceraphis***

8. Antenna longer than body length, apterous female unknown .... ***Calaphis***

- Antenna shorter than body length, apterous female commonly occur ....
.... ***Callipterinella***

Genus *Betacallis* Matsumura, 1919 오리나무알락진딧물속

Type species: *Betacallis alnicolens* Matsumura, 1919: 110.

Betucallis Zhang, Qiao and Zhong, 1999: 536.

Diagnosis. This genus is easily recognized by having dark transverse band on head venter, well developed marginal tubercles, abdominal tergite IV-V often with transverse band, wing vein clear cut, Rs well developed, Cu-1b often bordered with black pigmentation.

Host plant. *Alnus* spp.* (Betulaceae), *Betula* spp.* (Betulaceae), *Prunus cerasus* (Rosaceae), *Quercus* sp. (Fagaceae) (*, observed in this study; , Blackman & Eastop, 2017).

Distribution. Oriental (South-east Asia), Palearctic region (East Asia).

Remarks. *Betacallis* is distributed in Asian countries across Oriental and Palearctic regions, comprising 6 species. Although some species (*B. prunicola* and *B. querciphaga*) were recorded on *Prunus* and *Quercus*, host plants belonging to Betulaceae are regarded as the true host.

Key to the species of *Betacallis* Matsumura in Korea

1. Abdomen without black transverse band; Lengths of marginal setae on tergite I-VIII almost equal; marginal tubercles rarely pigmented ....***B. alnicolens***
2. Abdominal tergite IV-V and VIII with black transverse band; marginal setae on tergite V-VIII relatively very longer than those on tergite I-IV; marginal tubercles pigmented ....***B. trilineata* sp. nov.**

***Betacallis alnicolens* Matsumura, 1919 오리나무알락진딧물**

Betacallis alnicolens Matsumura, 1919: 110; Higuchi, 1972: 51; Basu, Ghosh and Raychaudhuri, 1974: 233; Eastop and Hille Ris Lambers 1976, 105; Quednau 1979: 504; Pashtshenko 1983: 29; Pashtshenko 1984: 51; Zhang, Guangxue, Liu, He and Zhong 1986: 404; Quednau and Shaposhnikov 1988: 1023; Remaudière and Remaudière 1997: 210; Qiao, Jiang and Zhang 2003: 694.

Diagnosis. This species is easily distinguished from congeneric species by abdominal tergite without dark transverse band, equal length of marginal setae on abdominal tergite I-VIII. On *Alnus* spp.

Description. Alate viviparous females. Color in iife. Head pale yellow to yellow with black venter band, compound eye red; Body pale yellow to greenish yellow with bluish-white wax spots on abdomen, body color varies according to seasonal changes; Ant.I-II concolorous with head, basal 2/3 and distal end of Ant.III, distal half of Ant.IV, distal 3/4 brown pigmented; SIPH black except basal part; cauda concolorous with body; Fore wing clear without pigmented spots, wing-veins with dusky tip, Cu-1b bordered with brown pigmentation; distal end of femur and tibia dark brown to black. Morphology (Table. S1; Fig. S1). Body elongated oval with 3.06-3.49 mm long; Head smooth with 4 pairs of long and pointed seate on head dorsum, Y shaped epicranial suture well developed, antennal tubercle smooth with 3 long and pointed setae; Antennae 6-segmented, very long and slender, about 1.52-1.64 times as long as body, antennal setae short pointed, inner margin of Ant.I slightly bulging, Ant.III with 20-28 rounded secondary rhinaria in a row on basal half, Ant.III-IV faintly imbricated, Ant.V-VI distinctly imbricated, primary rhinaria on Ant.V and Ant.VIb elongated oval with ciliation, PT 1.74-2.11 times as long as Ant.VIb; Rostrum not reaching miidle coxae, URS 0.15-0.17 mm with 11-13 accessory setae, 0.88-1.00 times as long as 2HT; Femur and tibia long and hairy, hind first tarsal chaetotaxy 6; Wing vein Cu-1b bordered with dark pigmentation; Pronotum with marginal pigmentation; Dorsal abdominal tergite I-VI with pair of long and pointed setae on elevations, dorsal abdominal tergite VIII with 6-9 setae, abdominal margin I-V with well developed tubercle with a single long and pointed seta, 4th marginal setae 0.13-0.16mm long, marginal tubercles faintly spiculose with long and pointed marginal seta; SIPH faintly reticulated, 0.14-0.20mm, distal flange moderately developed; Cauda knobbed 0.16-2.00mm with 6-11 long and pointed setae; Anal plate bilobated, each lobe with 10-14 setae.

Materials examined. 1 alate viviparous female, Seoul, South Korea, 14.viii.1963, Coll 1586, on *Corylus manshurica*, W.H. Paik, NAAS; 1 alate viviparous female, Gurye, JJ, South Korea, vi.1968, Coll 1586, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Suwon-si, GG, South Korea, 21-30.vi.1970, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Seoul, South Korea, 3.xi.1971, Coll 6900-B, on *Alnus sibirica*, W.H. Paik, NAAS; 10 alate viviparous female, Mt. Cheongryong, Pyeongseong-si, PN, North Korea, 18.vii.1985, Coll 85HA1456, on *Alnus japonica*, J. Havelka, NAAS; 10 alate viviparous female, Is. Daebudo, Ansan-si, CN, South Korea, 28.v.1999, Coll 990528SH-5, on *Alnus japonica*, S. Lee, NAAS; 1 alate viviparous female, Beolgyo-eub, Boseong-gun, JN, South Korea, 8.xi.2000, Coll 001108SH-25, on *Alnus hirsuta*, S. Lee, NAAS; 6 alate viviparous female, Hanhwa resort, Sokcho-si, GW, South Korea, 20.vi.2001, Coll 010620SH-31, on *Alnus japonica*, S. Lee, NAAS; 2 alate viviparous female, SNU, Gwanak-gu, Seoul, South Korea, 25.v.2004, Coll 040525HJ-4, on *Alnus hirsuta*, H. Kim, CALS SNU; 7 alate viviparous female, Mt. Hambaeksan, Taebaek-si, GW, South Korea, 28.viii.2013, Coll 130728YR-9, on *Alnus* sp., Y. Lee, CALS SNU; 2 alate viviparous female, Silnae, Hwacheon-gun, GW, South Korea, 1.v.2014, Coll 140501YR-12, on *Alnus* sp., Y. Lee, CALS SNU; 2 alate viviparous female, Okcheon-gun, CB, South Korea, 30.vi.2014, Coll 140630YR-1, on *Alnus* sp., Y. Lee, CALS SNU.

Host plant. Alnus spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle, on underside of leaves.

Distribution. Korea, China, and Japan.

Remarks. This species is very common and widely distributed in Korea. Among *Betacallis* species, *B. alnicolens* is the only species associated with *Alnus* spp. Apterous viviparous females are unknown.

Betacallis trilineata Lee, sp. nov. 세줄알락진딧물 (신칭)

Diagnosis. This species is differ in having black transverse band on abdominal tergite VIII and relatively short legth of PT with 0.36-0.47mm long (in other species, at least longer than 0.50mm) and relative length of URS 1.1 times as long as 2HT.

Description. Alate viviparous females. Color in iife. Head yellow with black venter band, compound eye red; Thorax dark yellow; Abdomen yellow mottled with yellowish green lightly covered with wax powder; Ant.I-II dart yellow with dark margins, Ant.III-VI entirely black; SIPH black except basal part; Cauda concolorous with body; Fore wing clear without pigmented spots, wing-veins with dusky tip, Cu-1b dark bordered, Rs, Co and PT dark; distal end of femur and tibia dark black. Morphology (Table. S2; Fig. S2). Body elongated oval with 2.07-2.59 mm long; Head smooth with 3 pairs of long and pointed seate on head dorsum, Y shaped epicranial suture well developed, antennal tubercle smooth with 1-2 short pointed setae each; Antenna 6-segmented, very long and slender, about 1.43-1.52 times as long as body, antennal setae short and pointed, inner margin of Ant.I slightly bulging, Ant.III with 24-30 narrow elliptical secondary rhinaria in a row on 2/3, Ant.III-IV faintly imbricated, Ant.V-VI distinctly imbricated, primary rhinaria on Ant.V and Ant.VIb elongated oval with ciliation, PT 1.57-1.77 times as long as Ant.VIb; Rostrum not reaching miidle coxae, URS 0.14-0.15 mm with 7-8 accessory setae, 1.00-1.07 times as long as 2HT; Femur and tibia long and hairy, hind first tarsal chaetotaxy 6, longest setae on HTB 0.12-0.15 mm long; Wing vein Cu-1b bordered with dark pigmentation, Rs, Co and PT dark; Pronotum with marginal pigmentation; Abdominal dorsum I-VII with 2 pairs of long and pointed setae, abdominal dorsum VIII with 7-9 spinal setae, abdominal margin I-V with well developed tubercle with a long and pointed seta, 4th marginal setae 0.02-0.06mm long; SIPH faintly reticulated, 0.10-0.15mm, distal flange moderately developed; Cauda knobbed 0.11-0.13mm with 5-6 long and pointed setae; Anal plate bilobated, each lobe with 8-9 setae.

Types. Holotype. 1 alate viviparous female, Mt. Ilwolsan, Yeongyang-gun, GB, South Korea, 24.vi.2014, Coll 140624YR-12, on *Betula* sp., Y. Lee, CALS SNU; Paratypes. 20 alate viviparous females, same data as the holotype.

Host plant. Betula sp.* (Betulaceae).

Distribution. Korea.

Biology. Monoecius holocyclic lifecycle, on underside of leaves.

Etymology. The species name *trilineata* is derived from Latin suffix tri- (three) and -lineata (lined), referring to 3 transverse band on abdomen.

Remarks. This species was only collected from Mt. Ilwolsan. Apterous viviparous females are unknown.

Genus *Betulaphis* Glendenning, 1926 자작알락진딧물속 (신칭)

Type species: *Betulaphis occidentalis Glendenning*, 1926: 96

= *Betulaphis quadrituberculata* (Kaltenbach, 1843).

Diagnosis. This genus is morphologically similar to *Neobetulaphis* Basu. However, it differs in having triangular shaped cauda and head without distinct fronsal tubercles.

Host plant. *Betula* spp.* (Betulaceae).

Distribution. Australian, Nearctic, Oriental, Palearctic region.

Remarks. *Betulaphis* is small genus with 5 species in the world. All known species are live on *Betula* spp. At the very first time, Quednau (1979) recorded this genus based on *B. japonicus* from North Korea. The species name *B. japonicus* has been synonymized by himself (Quednau, 1997). In this study, I firstly recognized this genus from South Korea.

Betulaphis quadrituberculata (Kaltenbach, 1843) 자작알락진딧물 (신칭)

Aphis quadrituberculata Kaltenbach, 1843: 134; Walker, 1852: 951.

Aphis 4tuberculata Kaltenbach, 1874: 609.

Aphis inhaerens Walker, 1852: 1041.

Myzocallis quadrituberculatus Mordvilko, 1909: 377.

Betulaphis quadrituberculata Hille Ris Lambers, 1947: 330; Börner, 1952: 57; Quednau, 1954: 23; Hille Ris Lambers, 1955: 18; Richards, 1969: 558; Robinson, 1979: 24; Remaudière & Remaudière, 1997: 210.

Betulaphis aureus Richards, 1961: 489.

Betulaphis quadrituberculata intermedia Börner, 1952: 58.

Betulaphis japonica Takahashi, 1961: 4.

Pterocallis minimum van der Goot, 1912: 83.

Betulaphis occidentalis Glendenning, 1926: 96.

Betulaphis quadrula Zhang, Zhang & Tian, 1995: 464.

Diagnosis. This species is superficially similar to *B. brevilosa* Börner, 1940 but differ in having smooth and non wrinkled integument and relatively short length of setae on abdominal dorsum and margins.

Description. Apterous viviparous females. Color in iife. Body pale to whitish yellow with lemon yellow abdomen; Compound eye red; Appendages including antenna and legs pale, distal part of tarsi slightly pigmented; Cauda and SIPH concolorous with body. Morphology (Table S3; Fig. S3). Body oval spindle shaped, 1.59-2.19mm long; Head with 5 pairs of cephalic capitate setae on triangular elevations, head surface spiculose, epicranial poorly suture developed, antennal tubercle developed; Antenna 6-segmented, about half length of body (0.54-0.56), inner margin of Ant.I slightly bulging, Ant.III-VI distinctly imbricated, Ant.III without secondary rhinaria, longest setae on Ant.III 0.33-0.50 times as long as BDAnt.III, ciliated primary rhinaria on Ant.V and VI rounded, PT 1.00-1.20 times as long as Ant.VIb, Ant.VIb with 1 seta; Rostrum reaching to middle coxae, URS 0.07-0.09mm long with 4-6 accessory setae, 0.70-0.82 times as long as 2HT; Longest setae on HTB 1.00-1.67 times as long as middle width of HTB, hind tarsal chaetotaxy 5; Abdominal tergite without sclerotized, abdominal margin with a pair of conspicuous capitate seta on small triangular elevation, dorsal abdomininal tergites with capitate spinal setae, dorsal abdomininal tergite VIII with 5-6 spinal capitate setae on small elevations, spicules faintly developed on abdomen; SIPH cylindrical shaped 0.07-0.11mm long with flange; Cauda triangular 0.07-0.10mm long bearing 6-8 long and fine setae, spicules developed; Anal plate bilobed, each lobe with 7-9 pointed setae.

Materials examined. 5 apterous viviparous females, Haesanryeong, Hwacheon-gun, GW, South Korea, 5.vi.2016, Coll 160605YR-2, on *Betula schimidtii*, Y. Lee & H. Lee., CALS SNU.

*Host plant. Betula schimidtii** (Betulaceae).

Biology. Monoecius holocyclic lifecycle, on underside of leaves.

Distribution. Widely distributed in Europe across Asia (Korea, China and Molglia) and recently introduced into North America.

Remarks. This species was subdivided into three subspecies: *B. quadrituberculata* spp. *brevilosa*, *B. quadrituberculata* spp. *intermedia*; and *B. quadrituberculata* spp. *quadrituberculata*, according to variable lengths of dorsal and marginal setae. However, as a results of intensive morphological studies (Heie, 1983; Quenau & Chakrabati, 1980), *intermedia* was synonymized and *brevilosa* was separated as a distinct species. Alate viviparous females not observed in this study.

Genus *Boernerina* Bramstedt, 1940 납작알락진딧물속 (신칭)

Type species: *Bornerina depressa* Bramstedt, 1940: 13.

Boernerinella Hille Ris Lambers & Hottes, 1962: 112.

Börnerina Bramstedt, 1940: 13.

Diagnosis. This genus have unique morphology with flattened abdomen, conspicuous rectangular projections on the head, abdominal margin with asymmetric tubercles which looks like sawtooth shaped margin, typically having 5-segmented antenna (except for *B. occidentalis* Hille Ris Lambers & Hottes, 1962).

Host plant. *Alnus* spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle, on underside of leaves.

Distribution. Nearctic and Palearctic regions.

Remarks. This genus is small genus which is mainly distributed in Norhtern hemisphere of Palearctic to Nearctic regions, comprising 5 species. All species is affiliated with *Alnus* spp. (Betulaceae). In Korea, only one species, *B. occidentalis* is newly recognized from Korea in this study.

Boernerina occidentalis (Hille Ris Lambers & Hottes, 1962) 납작알락진딧물 (신칭)

Börnerina occidentalis Hille Ris Lambers & Hottes, 1962: 112.
Boernerina occidentalis Eastop & Hille Ris Lambers, 1976: 107; Remaudière & Remaudière, 1997: 211.

Diagnosis. This species is easily recognized from other species by having 6-segmented antenna and relatively inconspicuous rectangular projections on the head.

Description. Apterous viviparous females. Color in iife. Body pale to pale yellow; Compound eye dark red; Appendages including antenna and legs pale, distal part of tarsi slightly pigmented; Cauda and SIPH concolorous with body. *Morphology* (Table S4; Fig. S4). Body flattened, elongated oval with 2.42-2.48 mm long; head integument wrinkled, frons with a pair of anterior triangular projections, single flabellate seata on each projection, head dorsum with pair of blunt projections with 2-3 flabellate seatae; Antenna 6-segmented, short and stout shaped, antennal setae short and mostly with acute apices and a few with flabellate apices, 0.47-0.48 times as long as body legnth, distal margin of Ant.I slightly bulging, Ant.I-III faintly imbricated, Ant.IV-VI distinctly imbricated, Ant.III without secondary rhinaria, primary rhinaria on Ant.V and Ant.VIb round shape with ciliation, length of PT and Ant.VIb almost same; Rostrum reaching to middle coxae, URS 0.14mm long with 7 accessory setae, 1.08 times as long as 2HT; Femur and tibia short and slender, hind first tarsal chaetotaxy 8-9, longest setae on HTB 0.60 times as long as middle width of HTB; Abdomen flattend with dorsal sculpturing, abdominal tergite VIII with 8 spinal setae on a small elevation, abdominal margin I-VIII with single flabellate seta on sculpturous asymmetric tubercle which makes sawtooth shaped margin; SIPH short 0.07mm long, distal flange well developed; Cauda knobbed 0.14mm long with 14-15 pointed setae; Anal plate bilobated, each lobe with 9-10 setae.

Materials examined. 2 apterous viviparous females, Mt. Baekdusan, YG, North Korea, 22.vi.2009, Coll 090622-82, on *Alnus* sp., S. Lee et al., CALS SNU.

Host plant. Alnus sp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle, on underside of leaves.

Distribution. Korea (North), Alaska, North America and North-eastern Siberia.

Remarks. This species is originally recorded from Alaska and now also recorded from North America and North-eastern Siberia. This species was collected only from Mt. Baekdusan in North Korea. Alate viviparous females not observed in this study.

Genus *Calaphis* Walsh, 1863 검은맥알락진딧물속

Type species: *Calaphis betulella* Walsh, 1863: 301.

Kallistaphis Kirkaldy, 1905: 417.

Neocallipterus van der Goot, 1915: 288, 319.

Siphonocallis Del Guercio, 1914: 293.

Diagnosis. This genus is similar to *Callipterinella* van der Goot in having conspicuous black broadered wing veins but can be distinguished by having antenna longer than body length.

Host plant. *Betula* spp.* (Betulaceae), *Magnolia* spp.* (Magnoliaceae), *Myrica* spp. (Myricaceae).

Distribution. Australian, Nearctic and Palearctic regions.

Remarks. This genus is the largest genus in the subtribe Calaphidina, including 14 species in the world. *Calaphis* species are mainly distributed in Nearctic regions (mainly North America) and 6 species is recorded from Palearctic regions. Most species of *Calaphis* is associated with *Betula* spp.

(Betulaceae) except for 1 species on *Myrica* sp. and 2 species on *Magnolia* spp. Japanese aphidologists considered that Magnolia feeding species as a distinct genera named *Neocalaphis*. However, this genus name is listed as invalid name now.

Key to the species of *Calaphis* Walsh in Korea

1. Antennal PT significantly very long about 0.93mm (0.88-1.10), wing vein not conspicuously bordered, On *Magnolia* spp..................................***C. magnoliae***

- Antennal PT 0.54mm (0.37-0.63), wing vein conspicuously black-borderded, On *Betula* spp...***C. similis***

***Calaphis magnolia* Essig & Kuwana, 1918 목련알락진딧물**

Calaphis magnolia Essig and Kuwana, 1918: 85.

Euteraphis magnolifoliae Shinji, 1923: 305.

Neocalaphis magnoliae Takahashi, 1965: 55; Higuchi, 1972: 66; Eastop and Hille Ris Lambers, 1976: 119, 194, 309.

Neocalaphis magnolia Higuchi, 1972: 66.

Diagnosis. This species can be easily distinguished from congeneric birch feeding species by having extremely long length of PT. Compaired to similar species *C. magnolicolens* Takahashi, 1921, *C. magnoliae* can be distinguished in having smaller body length 1.16-1.66mm (*C. magnolicolens* 2.9 mm) and relative length of URS and 2HT 0.5-0.7 (*C. magnolicolens* 1.0-1.3).

Description. Alate viviparous females. Color in iife. Body entirely pale to pale yellow, compound eye red; Ant.I-II pale, distal end of Ant.III-V, Ant.VIb and distal half of PT pigmented; legs pale, distal end of 2HT slightly pigmented; Cauda and SIPH pale. *Morphology* (Table S5; Fig. S5). Body oval, 1.16-1.66 mm long; Head smooth, epicranial suture developed, antennal tubercle smooth; Antenna 6-segmented, long and sleder, 1.30-1.96 times as long as body length, antennal setae short and pointed, inner margin of Ant.I bulging, Ant.III-VI imbricated, Ant.III with 6-11 rounded secondary rhinaria in a row on 2/3, PT extremely long, 3.71-6.1 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.06-0.07mm long with 3-4 accessory setae, 0.55-0.70 times as long as 2HT; Femur and tibia slender and long, hind first tarsal chaetotaxy 6, setae on HTB short, 0.3mm long; Wing veins inconspicuous with dusky tip, Rs absent; Pronotum without marginal pigmentation; Abdominal dorsum I-V with a pair of small elevation, abdominal tergite VIII with 5-6 setae, each abdominal margin with a single pointed seta on nipple like elevation; SIPH cylindrical shaped 0.05-0.07mm long, distal flange moderate; Cauda knobbed 0.08-0.10mm with 6-9 pointed setae; Anal plate slightly bilobed, each lobe with 9-10 setae.

Materials examined. 7 alate viviparous females, Moga-myeon, Eonong-ri, Icheon-si, GG, South Korea, 10.ix.2011, Coll 110910YR-1, on *Magnolia* sp., Y. Lee, CALS SNU; 4 alate viviparous females, South Korea Univ., Anam-dong, Seoul, South Korea, 18.vii.2013, Coll 130718YR-20, on *Magnolia* sp., Y. Lee, CALS SNU; 1 alate viviparous female, SNU, Gwanak-gu, Seoul, South Korea, 3.ix.2013, Coll 130903YR-1, on *Magnolia* sp., Y. Lee, CALS SNU.

Host plant. Magnolia spp.* (Magnoliaceae).

Biology. Monoecius holocyclic lifecycle, on underside of leaves.

Distribution. Korea and Japan.

Remarks. This species is originally described from Japan. Overwintering form of this species have black abdominal markings. Apterous viviparous females are unknown.

Calaphis similis Quednau, 1979 검은맥알락진딧물

Calaphis similis Quednau, 1979: 502; Quednau and Shaposhnikov, 1988: 1023; Remaudière and Remaudière, 1997: 211.

Calaphis betulaecolens levitubulosa Pashtshenko, 1984: 45, 53.

Diagnosis. This species is similar to *C. betulaecolens* (Fitch, 1851) and *C. leonardi* Quednau, 1971 but can be recognized by having black bordered wing vein, weakly developed unpigmented Rs. Compared to *C. similis*, *C. betulaecolens* has longer length of URS than those of 2HT, *C. leonardi* has shorter appendaged and longer setae on Ant.III.

Description. Alate viviparous females. Color in iife. Body pale greenish yellow to yellow, body color varies according to the seasonal changes, alatoid nymph and alate viviparous females show red pigmentation on marginal thorax, and abdominal dorsum in the fall; Compound eye red, Ant.I-II concolorus with head, Ant.III, distal half of Ant.IV, 5/6 of Ant.V, Ant.VI dark; Femur pale to yellow, tibia and tarsi black; Fore wing clear with conspicuous black-bordered wing veins; Cauda and SIPH concolorus with body. *Morphology* (Table S6; Fig.

S6). Body oval, 2.05-3.03mm long; Head smooth, Y shaped epicranial suture well developed, Antennal tubercle smooth with 3-4 short pointed setae; Antenna 6-segmented, long and sleder, antennal setae short and pointed, 1.31-1.79 times as long as body length, inner margin of Ant.I slightly bulging, distal 1/3 of Ant.III-VI imbricated, Ant.III with 18-23 secondary rhinaria, primary rhinaria slightly elongated with ciliation, PT 1.66-2.10 times as long as Ant.VIb; Rostrum barely reaching to middle coxae, URS 0.13-0.14mm long with 8-12 accessory setae, 0.87-1.00 times as long as 2HT; Femur and tibia long and slender, hind first tarsal chaetotaxy 7, longest setae on HTB 1.00-1.20 times as long as middle width of HTB; Wing veins conspicuous with black bordered, Rs weakly developed; Abdominal dorsal tergite I-VII with a pair of pointed seta on cone shaped elevation, abdominal tergite VIII with 6-8 spinal setae, abdominal margin I-VI with a single pointed seta on well developed marginal tubercle; SIPH cylindrical 0.11-0.17mm long, distal flange moderately developed; Cauda knobbed 0.6-0.19mm long with 6-8 pointed setae; Anal plate moderately bilobed, each lobe with 10-13 setae.

Materials examined. 3 alate viviparous females, Suwon-si, GG, South Korea, 15.x.1963, Coll 2745, on *Betula platyphylla*, W.H. Paik, NAAS; 1 alate viviparous female, Suwon-si, GG, South Korea, 21.vi.1967, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Suwon-si, GG, South Korea, 28.x.1967, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Suwon-si, GG, South Korea, vi. 1968, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Eumseong-gun, CB, South Korea, 11-20.x.1969, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Seoul, South Korea, 3.xi.1970, Coll 6145, on *Betula costata*, W.H. Paik, NAAS; 1 alate viviparous female, Suwon-si, GG, South Korea, 17.v.1971, Coll 6302, yellow pan trap, W.H. Paik, NAAS; 16 alate viviparous females, Churyongpo-ri, Gyeongseong-gun, HB, North Korea, 19.vi.1987, Coll 87HA1889, on *Betula davurica*, J. Havelka, NAAS; 9 alate viviparous females, Jinan-gun, JB, South Korea, 29.viii.2000, Coll 000829TM-6, on *Betula* sp., TM Han, NAAS; 3 alate viviparous females, Guryongryeong, Hongcheon-gun, GW, South Korea, 16.vi.2005, Coll 050616HJ-5, on *Betula* sp. H. Kim, CALS SNU; 3 alate viviparous females, Micheongol-restriction area, Yangyang-gun, GW, South Korea, 16.vi.2005, Coll 050616HJ-19, on *Betula shmidtii* H. Kim, CALS SNU; 4 alate viviparous females, Osan-si, GG, South Korea, 23.iv.2009, Coll 090423HJ-30, on *Betula* sp., Y. Lee, CALS SNU; 3 alate viviparous females, Bangtaesan restriction area, Inje-gun, GW, South Korea, 21.vi.2013, Coll 130621YR-25, on *Betula costata*, Y. Lee, CALS SNU; 19 alate viviparous females, SNU, Daehak-dong, Gwanak-gu, Seoul, South Korea, 26.vi.2013, Coll 130626YR-1, on *Betula* sp., Y. Lee & H. Lee, CALS SNU; 1 alate viviparous female, Pocheon-si, GG, South Korea, 9.ix.2013, Coll 130709YR-2, on *Betula* sp., Y. Lee, CALS SNU; 6 alate viviparous females, Mt. Yongmunsan, Yangpyeong-gun, GG, South Korea, 13.vii.2013, Coll 130713YR-8, on *Betula* sp., Y. Lee & H. Lee, CALS SNU; 2 alate viviparous females, Yongdaeri, Inje-gun, GW, South Korea, 1.viii.2013, Coll 130801YR-4, on *Betula* sp., Y. Lee, CALS SNU; 5 alate viviparous females, Mt. Chiaksan, Wonju-si, GW, South Korea, 13.viii.2013, 130820YR-13; 18 alate viviparous females, Mt. Hambaeksan, Taebaek-si, GW, South Korea, 8.ix.2013, Coll 130908YR-8, *Betula costata*, Y. Lee, CALS SNU; 81 alate viviparous female, Silnae, Hwacheon-gun, GW, South Korea, 1.v.2014, Coll 140501YR-10, on *Betula* sp., Y. Lee, CALS SNU.

Host plant. Betula spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle, on underside of leaves.

Distribution. Korea, China, Japan and Eastern Siberia.

Remarks. This species was originally described from North Korea based on overwintering form. In Korea, this species is very common and occurs on various *Betula* spp.

Genus *Callipterinella* van der Goot, 1913 작은알락진딧물속 (신칭)

Type species: *Aphis betularia* Kaltenbach, 1843: 119.

= *Callipterinella tuberculata* (von Heyden, 1837)

Oncodaphis Amyot, 1847: 479.

Procalaphis Quednau, 1954: 23, 47.

Diagnosis. This genus is morphologically similar to *Calaphis* Walsh, 1863 but can be distinguished by small body size, short length of PT and cauda knob not distinctly developed.

Host plant. Betula spp.* (Betulaceae).

Distribution. Nearctic and Palearctic regions.

Remarks. This genus is small genus comprising only 3 species in the world. *Callipterinella* spp. is originally distributed Europe across East Asia but, recently

C. callipterinella and *C. minutissima* has been introduced into North America. All species of *Callipterinella* is associated with *Betula* spp. (Betulaceae). Apterous viviparous female commonly occur.

Key to the species of *Callipterinella* van der Goot in Korea

1. Abdominal tergite without dark band, setae on head and abdominal tergite slender not blunt in shape, PT 0.15-0.21mm long, abdominal margin I-V with 1-2 marginal setae ....***C. calliptera***
2. Abdominal tergite with dark patch, setae on head and abdominal tergite blunt in shape, PT 0.32-38mm, abdominal margin I-V with 4-5 marginal setae ....***C. tuberculata***

***Callipterinella calliptera* (Hartig, 1841) 작은알락진딧물 (신칭)**

Aphis callipterus van der Goot, 1913: 369.

Aphis calliptera Walker, 1852: 1031.

Chaitophorus annulatus Koch, 1854: 7.

Chaitophorus betulae Buckton, 1879: 139.

Procalaphis callipterus Quednau, 1954: 23.

Calaphis callipterus Börner, 1952: 58; Mamontova, 1963: 23.

Callipterinella calliptera Higuchi, 1972: 56; Zhang, Guangxue and Tiesen Zhong, 1990: 328; Remaudière and Remaudière, 1997: 212.

Callipterinella callipterus Eastop and Hille Ris Lambers, 1976: 46, 120; Smith and Parron, 1978: 65; Blackman, 1980: 9.

Diagnosis. This species is differ from congeneric species by having 6-segmented antenna (*C. minutissima* Stroyan has 5-segmented antenna), 1/2 shorter length of PT (*C. callipterinella*, 0.15-0.21mm, *C. tuberculata* (von Heyden), 0.32-0.38mm), longer and pointed setae on head (*C. tuberculata* has shorter and blunted setae on head).

Description. Apterous viviparous females. Color in iife. Body greenish yellow to green, body color variable according to the seasonal changes, nymphs and viviparous females show dark transvers band on abdominal tergite in the over wintering season; Compound eye red; Ant.I-II concolorus with head, distal margin of Ant.III, distal half of Ant.IV, distal 2/3 of Ant.V and Ant.VI dark; Femur pale, Tibia and tarsi dark; Wing vein of fore wing conspicuous; Cauda and SIPH concolorus with body. *Morphology* (Table S7; Fig. S7). Body oval, 1.55-1.80mm; Head surface with spicules, frons and head dorsum with 0.06-0.08mm, most setae with pointed apices and some with blunted apices, epicranial suture weakly developed, antennal tubercle developed; Antenna 6-segmented, 0.57-0.68 times as long as body length, antennal setae pointed or blunted, inner margin of Ant.I slightly bulging, Ant.I-II weakly imbricated, Ant.III-VI distinctly imbricated, Ant.III with 4-7 rounded secondary rhinaria in a row on basal 2/3, primary rhinaria on Ant.V and Ant.VI rounded of slightly elongated, PT 1.67-1.89 times as long as Ant.VIb; Rostrum barely reaching to hind coxae, URS 0.10-0.12mm long with 6-8 accessory setae, 0.77-1.00 times as long as 2HT; Fore coxae small, longest setae on HTB 1.75-2.0 times as long as middle width of HTB, hind first tarsal chaetotaxy 8; Andominal dorsal tergite spiculose bearing various lengths of setae, abdominal tergite VIII with 7-9 setae, marginal tergite spiculose, I-V with 1-2 long and slightly blunted setae, abdominal margin VI-VIII with a single pointed seta, marginal tubercle not developed; SIPH 0.06-0.08mm long with spicules, distal flange moderate; Cauda knobbed, 0.06-0.09mm long with 6-9 pointed setae; Anal plate moderately bilobed, each lobe with 8-12 setae.

Alate viviparous females. Color in iife. Body greenish yellow to green; Compound eye red, Ant.I, basal of Ant.III and Ant.IV pale, rest of segments dark; Femur pale, tibia and tarsi dark; Cauda and SIPH concolorus with body. *Morphology* (Table S7; Fig. S7-2). Body oval 1.46-1.62mm long; Head integument wrinkled without spicules, Y shaped epicranial suture well developed, antennal tubercle developed, each tubercle with a pair of long setae, Antenna 0.77-0.88 times as long as body length, inner margin of Ant.I slightly bulging, Ant.I-II and basal half of Ant.III faintly imbricated, distal 1/2 of Ant.III-VI imbricated, Ant.III with 5-6 rounded secondary rhinaria, longest setae on Ant.III 0.67-1.00 times as long as BDAnt.III, primary rhinaria slightly elongated with ciliation, PT 1.91-2.67 times as long as Ant.VIb; Rostrum passing to middle coxae, URS 0.09-0.11mm long with 7-8 accessory setae, 0.82-1.00 times as long as 2HT; Femur and tibia short and slim, longest setae on HTB 2.00-2.67 times as long as middle width of HTB, hind first tarsal chaetotaxy 8; wing-veins conspicuous with dusky tip, slightly black-bordered, Rs developed; Abdominal dorsal tergite I-VII with various lengths of setae, abdominal tergite VIII with 6 spinal setae, abdominal margin 1-2 long and pointed setae on well developed marginal tubercle; Abdominal dorsal tergite I-V with single pointed seta on well developed marginal tubercle, 4th marginal tubercle with 6-8 setae; SIPH cylindrical shaped 0.06-0.07mm long, distal flange moderate; Cauda knobbed, about 0.07mm with 7-8 long and pointed setae; Anal plate moderately bilobed, each lobe with 11-12 setae.

Materials examined. 1 apterous viviparous female, Seoul, South Korea, 18.xi.1971, Coll 6984, *Betula* sp., W.H. Paik, NAAS; 29 apterous viviparous females and 18 alate viviparous females, SNU, Mt. Yongmunsan, Yangpyeong, GG, South Korea, 13.vii.2013, Coll 130713YR-3, *Betula* sp., Y. Lee & H. Lee, CALS SNU; 2 alate viviparous females, SNU, Daehak-dong, GW, Seoul, South Korea, 21.vii.2013, Coll 140426YR-11, *Betula* sp., Y. Lee & H. Lee, CALS SNU; 23 apterous viviparous females and 3 alate viviparous females, SNU, Daehak-dong, GW, Seoul, South Korea, 26.iv.2014, Coll 140426YR-11, *Betula* sp., Y. Lee & H. Lee, CALS SNU.

Host plant. Betula spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle, on underside of leaves near the petiole. Often ant-attended.

Distribution. Widely distributed in Europe across East Asia (Korea, China, Japan and Eastern Siberia) recently introduced into North America.

Remarks. According to many European authors, this species has been described as follows: having dark brownish head vertex and black transverse pigmentation on abdominal tergites. However, Korean specimens collected in the spring and summer exhibit lack of dark transverse band on abdominal tergites. Such abdominal band is only observed in the over wintering season in Korea.

***Callipterinella tuberculata* (von Heyden, 1837) 작은줄알락진딧물 (신칭)**

Aphis tuberculata von Heyden, 1837: 296; Ratzeburg, 1844: 218; Hottes, 1930: 183.

Aphis betularia Kaltenbach, 1843: 119.

Oncodaphis tuberculata Amyot, 1847: 479.

Chaitophorus tricolor Koch, 1854: 9.

Aphis betulae Lichtenstein, 1885: 21.

Calaphis tuberculata Börner, 1952: 58; Mamontova, 1963: 23.

Procalaphis tuberculata Quednau, 1954: 23; Steffan, 1972: 349.

Callipterinella tuberculata Eastop and Hille Ris Lambers, 1976: 85, 120; Blackman, 1980: 9; Remaudière and Remaudière. 1997: 212.

Callipterinella tubercuatla Zhang, Liu, He and Zhong, 1986: 404.

Diagnosis. Apterous viviparous females of this species is distinguished by having 6-segmented antenna (*C. minuttisima* has 5-segmented antenna), dark abdominal patches on abdominal tergite, twice longer length of PT (*C. callipterinella*, 0.15-0.21mm, *C. tuberculata*, 0.32-38mm), and short blunted hairs on head (*C. callipterinella* has longer and pointed setae on head).

Description. Apterous viviparous females. Color in iife. Not available. *Morphology* (Table S8; Fig. S8). Body oval, 1.48-2.16mm long; Head dark sclerotized with spiculse, frons and head dorsum with 0.07-0.09mm of thick and blunted setae, epicranial suture developed, antennal tubercle developed; Antenna about 0.81-0.82 times as long as body length, antennal setae blunted or pointed, Ant.I spiculose, inner margin of Ant.I slightly bulging, Ant.I-II weakly imbricated, Ant.III-VI distinctly imbricated, longest setae on Ant.III 0.50-1.00 times as long as BDAnt.III, PT 2.62-2.91 times as long as Ant.VIb; Rostrum reaching to middle coxae, URS 0.12-0.14mm long with 6-8 accessory setae, 0.87-1.00 times as long as 2HT; Hind first tarsal chaetotaxy 8, longest hind tibial setae 1.4-1.6 times as long as middle width of HTB; Thorax and abdominal tergite III-VIII with dark sclerotic band, abdominal tergite VIII with 9-11 setae, abdominal margin I-V with 5-8 thick and blunted setae, abdominal tergite VI-VIII with 2-3 marginal seta, marginal tubercle not developed; SIPH spiculose, 0.07-0.08mm long, distal flange moderately developed; Cauda knobbed, 0.05-0.06mm long with 9-14 pointed setae; Anal plate slightly bilobated, each lobe with 9-14 setae.

Materials examined. 4 Apterous viviparous females, Gyeongseong-gun, HB, North Korea, 19.vi.1987, Coll 87HA1937, on *Betula platyphylla*, J. Havelka, NAAS.

Host plant. Betula spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle, on underside of leaves near the petiole and vein of leaves. Often ant-attended.

Distribution. Korea, China, Eastern Siberia and widely distributed in Europe

Remarks. This species is newly recognized from Korea based on North Korean specimens. Alate viviparous females not observed in this study.

Genus *Clethrobius* Mordvilko, 1928 갈색알락진딧물속 (신칭)

Type species: *Callipterus giganteus* Cholodkovsky, 1899: 474.

= *Clethrobius comes* (Walker, 1848).

Clethrobus Qiao, Jiang & Zhang, 2003: 701.

Cletrobius Pashtshenko, 1984: 49.

Diagnosis. This genus is morphologically very similar to *Symydobius* Mordvilko, 1894 due to hairy body parts and dark abdominal pigmentation but can be distinguished from *Symydobius* by having only 1 seta on Ant.VIb and distinctly developed cauda knob (*Symydobius* spp. have tongue shaped cauda).

Host plant. Alnus spp.* and *Betula* spp.* (Betulaceae).

Distribution. Oriental and Palearctic regions.

Remarks. This genus is small genus comprising only 3 species in the world. Except for *C. comes* Walker, *C. dryobius* Chakrabarti & Raychaudhuri and *C. vermai* Ghosh & Quednau only distributed in Oriental regions (South China and India). All species of *Clethrobius* is associated with *Alnus* spp. and *Betula* spp. (Betulaceae). Apterous viviparous females are unknown.

Clethrobius comes (Walker, 1848) 갈색알락진딧물 (신칭)

Aphis comes Walker, 1848: 258; 1852: 937; Kaltenbach, 1874: 610.

Clethrobius comes Hille Ris Lambers, 1947: 332; Ghosh, Basu and Raychaudhuri, 1970: 68; Higuchi, 1972: 57; Eastop and Hille Ris Lambers, 1976: 49, 159; Quednau, 1979: 504; Remaudière and Remaudière, 1997: 212.

Betacallis comes Börner, 1952: 56; Mamontova, 1963: 25.

Callipterus giganteus Cholodkovsky, 1899: 474.

Clethrobius betulae Eastop and Hille Ris Lambers, 1976: 159.

Clethrobius pilosa Eastop and Hille Ris Lambers, 1976: 194.

Diagnosis. This species is easily recognized from congeneric species by having no hairs on SIPH.

Description. Apterous viviparous females. Color in iife. Head and thorax dark brown to blackish brown, compound eye red; Antenna entirely dark; Thorax shinny dark brown; Abdomen brown with dark transverse band and whitish wax band; Legs dark except for basal 1/3 of femur; SIPH and cauda concolorous with body. *Morphology* (Table S9; Fig. S9). Body elongated oval, 3.76-4.21mm long; Head surface wrinkled, Y shaped epicranial suture well developed, antennal tubercle developed, head dorsum with 0.08-0.13mm of pointed setae; Antenna hairy, slightly shorter or almost same with body length (0.85-1.00), Ant.I-III slightly imbricated, Ant.IV-VI distinctly imbricated, antennal setae long and pointed, Ant.III with 38-52 transversely elongate ciliated secondary rhinaria irregulary distributed on basal 2/3 of the segment, longest setae on Ant.III 1.50-2.20 times as long as BDAnt.III, ciliated primary rhinaria on Ant.V transversely elongated, primary rhinaria on Ant.VIb longitudinaly elongate, PT shorter than Ant.VIb (0.60-0.71 times as long as Ant.VIb), Ant.VIb with only 1 seta; Rostrum not reaching to middle coxae, URS 0.09-0.15mm long with 18-22 accessory setae, shorter than 2HT; legs long and slender with many hairs, longest setae on HTB 1.78-2.13 times as long as middle width of HTB, hind first tarsal chaetotaxy 7; Wing vein of fore wing normal, Pts and Rs well developed; Dorsal abdominal tergites I-VII with incomplete transverse sclerotic band, dorsal abdominal tergite VIII with well developed dark transverse sclerotic band bearing 20-22 setae, abdominal margin brownish sclerotized with 9-15 long and fine setae on each elevation, every margin with picules; SIPH cylindrical shaped 0.11-0.14mm long with distinct flange; Cauda knobbed, 0.18-0.21mm long with 16-26 long and fine setae, cauda knob indistinctly or distinctly developed; Anal plate almost rounded or slightly bilobed, each side of anal plate with 18-23 setae.

Materials examined. 9 alate viviparous females, Guryong-waterfall, Mt. Gumgangsan, North Korea, 23.vi.1985, Coll 85HA1178, on *Carpinus cordata*, J. Havelka, NAAS; 1 alate viviparous female, Samjiyeon-pond, Mt. Baekdusan, YG, North Korea, 15.vi.1988, Coll 88HA2994, on *Betula platyphylla*, J. Havelka, NAAS; 4 alate viviparous females, Manmulsang-area, Mt. Geumgangsan, North Korea, 23.v.1988, Coll 88HA2519, on *Betula costata*, J. Havelka, NAAS; 3 alate viviparous females, Manmulsang-area, Mt. Geumgangsan, North Korea, 24.v.1988, Coll 88HA2540, on *Betula costata*, J. Havelka, NAAS; 3 alate viviparous females, Manmulsang-area, Mt. Geumgangsan, North Korea, 24.v.1988, Coll 88HA2549, on *Betula* sp., J. Havelka, NAAS; 3 alate viviparous females, Manmulsang-area, Mt. Geumgangsan, North Korea, 24.v.1988, Coll 88HA2570, on *Betula costata*, J. Havelka, NAAS; 3 alate viviparous females, Manmulsang-area, Mt. Geumgangsan, North Korea, 24.v.1988, Coll 88HA2574, on *Betula costata*, J. Havelka, NAAS; 4 alate viviparous females, Manmulsang-area, Mt. Geumgangsan, North Korea, 24.v.1988, Coll 88HA2516, on *Betula costata*, J. Havelka, NAAS; 3 alate viviparous females, Manmulsang-area, Mt. Geumgangsan, North Korea, 24.v.1988, Coll 88HA2516, on *Betula costata*, J.

Havelka, NAAS; 2 alate viviparous females, Dunae, Hoengseong-gun, GW, South Korea, 2.vi.1999, Coll 990602SH-1, on *Betula platyphylla*, S. Lee, NAAS; 3 alate viviparous females, Sogeumgan, Jumunjin, Gangreung-si, GW, South Korea, 2.vi.1999, Coll 990602SH-32, host plant unknown, S. Lee, NAAS; 2 alate viviparous females, Jinbu-myeon, Pyeongchang-gun, GW, South Korea, 3.vi.1999, Coll 990602SH-27, on *Betula platyphylla*, S. Lee, NAAS; 3 alate viviparous females, Osaek, Yanyang-gun, GW, South Korea, 4.vi.1999, Coll 990602SH-53, on *Alnus* sp., S. Lee, NAAS; 1 alate viviparous female, Guidun-si, Inje-gun, GW, South Korea, 4.vi.1999, Coll 990602SH-67, on *Betula* sp., S. Lee, NAAS; 5 alate viviparous females, Yeonghwa-waterfall, Yeongwol-gun, GW, South Korea, 2.vi.2001, Coll 010531SH-32, on *Alnus japonica*, S. Lee, NAAS; 12 alate viviparous females, Guryong-ryeong, Hongcheon-gun, GW, South Korea, 16.vi.2005, Coll 050616HJ-4, on *Betula* sp., H. Kim, CALS SNU; 13 alate viviparous females, Micheongol-restriction area, Yangyang-gun, GW, South Korea, 16.vi.2005, Coll 050616SH-37, on *Betula* sp. S. Lee, CALS SNU; 3 alate viviparous females, Micheongol-restriction area, Yangyang-gun, GW, South Korea, 14.vii.2010, Coll 050616HR-11, host plant unknown, H. Choi, CALS SNU; 15 alate viviparous females, Bangtaesan restriction area, Inje-gun, GW, South Korea, 21.vi.2013, Coll 130621YR-24, on *Betula costata*, Y. Lee, CALS SNU; 1 alate viviparous female, Goseong-gun, GN, South Korea, 4.vi.2014, Coll 140604YR-1, on *Betula* sp., Y. Lee & H. Lee, CALS SNU; 1 alate viviparous female, Pillye-valley, Inje-gun, GW, South Korea, 4.vi.2014, Coll 140604YR-36, on *Betula* sp., Y. Lee & H. Lee, CALS SNU; 1 alate viviparous female, Mt. Ilwolsan, Yeongyang-gun, GB, South Korea, 24.vi.2014, Coll 140624YR-14, on *Betula* sp., Y. Lee, CALS SNU.

Host plant. Alnus spp.* and *Betula* spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle, on young twigs and leaves. Often ant-attended.

Distribution. Korea, China, Japan, India and widely distributed in Europe.

Remarks. This species is one of the most common species in Korea. In the past, *Alnus* feeding populations regarded as dinstinct species, *C. giganteus* Cholodkovsky but *C. giganteus* was synonymized because of no morphological differences and lack of host use restriction between the two species. Among North Korean specimens collected by J. Havelka, 9 specimens were collected on *Carpinus cordata*. However, this host plant can be misidentified.

Genus *Euceraphis* Walker, 1870 가루알락진딧물속 (신칭)

Type species: *Aphis betulae* Walker, 1870: 2001.

= *Euceraphis punctippenis* (Zetterstedt, 1828): 559.

Callipteroides Mordvilko, 1909: 377.

Nigritarsifex Amyot, 1847: 480.

Quippelachnus Oestlund, 1923: 133, 134.

Diagnosis. This genus is morphologically similar to *Clethrobius* Mordvilko but differ in having sparse hairs on body parts, abdominal margin with about 2-6 hairs and abdominal tergite VIII bearing 7-8 hairs.

Host plant. Alnus spp.* and *Betula* spp.* (Betulaceae).

Distribution. Nearctic and Palearctic regions.

Remarks. This genus comprises 11 species in the world. *Euceraphis* spp. are distributed in temperate resions of Nearctic and Palearctic regions. Recently, *E. betulae* (Koch, 1855) has been introduced into Australian region (Australia and New Zealand). All species of *Euceraphis* is associated with *Alnus* spp. and *Betula* spp. (Betulaceae). Apterous viviparous female unknown.

Key to the species of *Euceraphis* Walker in Korea

1. Abdominal tergite I-VIII with dark sclerotic transeverse band ....
....***E. nigra* sp. nov.**

- Dark sclerotic transeverse band never developed on every tergite **2**

2. Ant.III with 30-38 secondary rhinaria, Ant.VIb 1.74-1.90 times as long as 2HT
....
....***E. caerulescens***

- Ant.III with 15-20 secondary rhinaria, Ant.VIb 1.30-1.61 times as long as 2HT
....**3**

3. Ant.VIb 1.61-2.14 times as long as URS............................. ***E. papyrifericola***

- Ant.VIb 2.14-2.47 times as long as URS ....***E. punctipennis***

Euceraphis caerulescens **Pashtshenko, 1984 푸른가루알락진딧물속 (신칭)**

Euceraphis caerulescens Pashtshenko, 1984: 8-17; Remaudière and Remaudière, 1997: 213; Blackman and De Boise, 2002: 333.

Diagnosis. This species can be distinguished from congeneric species by having 2.03-2.28mm of Ant.III and Ant.VIb 1.74-1.90 times as long as 2HT. In over wintering season, dark sclerotic band developed on abdominal tergite IV-V.

Description. Alate viviparous females. Color in iife. Head pale green, compound eye red; Center of mesonotum brown; Body pale geen; Ant.I-III, basal half of Ant. III dusky, distal joint of Ant.III, distal half of Ant.IV- VI dark pigmented, distal half of femur and tibiae dusky; SIPH and cauda concolorous with body. *Morphology* (Table S10; Fig. S10). Body elongated oval, 3.77-4.96mm long; Head frons slightly wrinkled, Y shaped epicranial suture well developed, antennal tubercle developed; Antenna long and slender, 1.16-1.49 as long as body length, Ant.I-III faintly imbricated, Ant.IV-VI distinctly imbricated, antennal setae short and pointed, longest setae on Ant.III 0.29-0.57 times as long as BDAnt.III, Ant.III with 30-38 transversely elongate secondary rhinaria in a row on basal 1/2 of the segment, ciliated primary rhinaria on Ant.V transversely rounded, primary rhinaria on Ant.VIb longitudinaly elongate, PT 0.64-0.78 times as long as Ant.VIb, Ant.VIb with only 1 short and pointed seta; Rostrum not reaching to middle coxae, URS 0.13-0.16mm long with 8-11 accessory setae, 0.59-0.71 times as long as 2HT; legs long and slender with many hairs, longest setae on HTB 1.29-2.14 times as long as middle width of HTB, hind first tarsal chaetotaxy 8; Dorsal abdominal tergites without transverse sclerotic band, dorsal abdominal tergite VIII with 6-9 setae, abdominal margin without sclerotic patch, bearing 4-5 long and fine setae on marginal tuibercle; Wing-vein of fore wing normal, Pts and Rs well developed; SIPH cylindrical shaped 0.16-0.19mm long with distinct flange; Cauda knobbed, 0.24-0.26mm with 12-16 long and fine setae; Anal plate broadly rounded or slightly bilobed, each side of anal plate with 10-12 setae.

Materials examined. 1 alate viviparous female, Gyeongseong-gun, HB, North Korea, 19.vi.1987, Coll 87HA1892, *Betula davurica*, J. Havelka, NAAS; 3 alate viviparous females, Guidun-ri, Inje-gun, GW, South Korea, 4.vi.1999, Coll 990602SH-67, *Betula* sp., S. Lee, NAAS; 2 alate viviparous females, Dunnae, Hoengseong-gun, GW, South Korea, 2.vi.1999, Coll 990602SH-1, *Betula platyphylla*, S. Lee, NAAS; 2 alate viviparous females, Mt. Hambaeksan, Taebaek-si, GW, South Korea, 8.ix.2013, Coll 130908YR-8, *Betula* sp., Y. Lee & H. Lee, CALS SNU; 14 alate viviparous females, Goseong-gun, GW, South Korea, 4.vi.2014, Coll 140604YR-5, *Betula* sp., Y. Lee & H. Lee, CALS SNU.

Host plant. *Alnus* spp.* and *Betula* spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle, on underside of leaves.

Distribution. Korea, Japan, Eastern Siberia.

Remarks. This species is the largest species among congeneric species distributed in Korea. As agreement of earlier studies, this species occurs on various *Betula* spp. In Korea, I couldn’t find this species on *Alnus* spp. In the over wintering season, they show different body color.

***Euceraphis nigra* Lee, sp. nov. 검은가루알락진딧물 (신칭)**

Diagnosis. This species is easily recognized from congeneric species by having dark brown colored head, thorax and distinctly developed sclerotic band on abdominal tegites I-VIII.

Description. Alate viviparous females. Color in iife. Head and pronotum entirely yellowish dark brown, compound eye red; antenna entirely dark; Mesonotum reddish brown; Abdomen yellow with dark transeverse band; Legs entirely dark; Pts of fore wing dark; SIPH dark; Cauda concolorous with body; Entire body covered with bluish white wax. *Morphology* (Table S11; Fig. S11). Body elongated oval, 3.34-3.67mm long; Head wrinkled, head dorsum with 0.02-0.03mm pointed hair like setae, Y shaped epicranial suture well developed, antennal tubercle developed; Antenna 6-segmented, 1.10-1.41 times as long as body length, Ant.I-III faintly imbricated, Ant.IV-VI distinctly imbricated, longest setae on Ant.III 0.29-0.75 times as long as BDAnt.III, Ant.III with 20-43 transversely elliptical secondary rhinaria in a row on basal 2/5 of the segment, ciliated primary rhinaria on Ant.V rounded, primary rhinaria on Ant.VIb longitudinaly elongate, PT 0.63-0.77 times as long as Ant.VIb, Ant.VIb with only 1 short and pointed seta; Rostrum not reaching to middle coxae, URS 0.14-0.16mm long with 8-10 accessory setae, 0.67-0.80 times as long as 2HT; Legs long and slender with many hairs, longest setae on HTB 1.14-1.40 times as long as middle width of HTB, hind first tarsal chaetotaxy 8; Dorsal abdominal tergites with dark transverse sclerotic band, dorsal abdomen I-VII with 2 pairs of spinal setae on elevations with cribriformed wax gland pore, dorsal abdominal tergite VIII with 7-8 setae, abdominal margin I-V with sclerotic patch, bearing 3-4 short and pointed setae on marginal tubercle, cribriformed wax gland pore developed;

Wing vein clear cut, Pts of fore wing blackish, Rs well developed; SIPH dark sclerotized, cylindrical shaped, 0.11-0.12mm long with distinct flange; Cauda knobbed, 0.19-0.25mm with 11-13 setae; Anal plate broadly rounded or slightly bilobed each side of anal plate with 10-13 setae.

Types. Holotype. 1 alate viviparous female, Mt. Baekdusan, YG, North Korea, 22.vi.2009, Coll 090622SH-80, *Betula* sp., S. Lee, CALS SNU; Paratypes. 20 alate viviparous females same data as holotype.

Host plant. Betula sp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle, on underside of leaves.

Distribution. Korea.

Remarks. This species has been only collected from North Korea. This species is morphologically distinct from any other species by having dark brown colored head, thorax and sclerotic band on every abdominal tergite. *Euceraphis* spp. have seasonally variable dark sclerotic bands on abdominal dorsum. In many cases, dark cross bands are never present in spring. According to Blackman (1977), sclerotic band developed on whole abdominal tergite in the most extreme form of *E. betulae*. But this species has different morphological features such as pale green colored head and 0.17-0.33mm of Ant.VIb.

***Euceraphis papyrifericola* Blackman, 2002 종이가루알락진딧물 (신칭)**

Euceraphis papyrifericola Blackman, 2002: 330.

Diagnosis. This species is morphologically similar to *E. punctipennis* but differs in having pale head without dark brown markings and Ant.VIb 1.61-2.14 times as long as URS.

Description. Alate viviparous females. Color in iife. Head yellowish green, compound eye red; Antenna entirely dusky; Torax and abdomen yellowish green; Legs dusky except for coxae and basal 1/4 of marginal femur; Marginal tip of wing vein of fore wing dark bordered; SIPH and cauda concolorous with body; Entire body slightly covered with bluish white wax. *Morphology* (Table S12; Fig. S12). Body elongated oval, 3.04-4.11mm long; Head slightly wrinkled, Y shaped epicranial suture well developed, antennal tubercle developed, head dorsum with 0.02-0.03mm of short and pointed setae; Antenna 6-segmented, inner margin of Ant.I slightly bulging, Ant.I-II faintly imbricated with wax gland pores, distal half of Ant.IV-VI distinctly imbricated, 1.16-1.59 times as long as body length, antennal setae short and pointed, longest setae on Ant.III 0.43-0.57 times as long as BDAnt.III, Ant.III with 17-19 transversely elliptical secondary rhinaria in a row on basal 1/3 of the segment, ciliated primary rhinaria on Ant.V rounded, primary rhinaria on Ant.VIb longitudinaly elongate, PT 0.69-0.86 times as long as Ant.VIb, Ant.VIb with only 1 short and pointed seta; Rostrum not reaching to middle coxae, URS 0.14-0.18mm long with 9-11 accessory setae, 0.61-0.86 times as long as 2HT; Legs long and slender with many hairs, longest setae on HTB 1.00-1.60 times as long as middle width of HTB, hind first tarsal chaetotaxy 8; Dorsal abdominal tergites without transverse sclerotic band, dorsal abdominal tergite VIII with 5-8 setae, abdominal margin without sclerotic patch, bearing 3-5 setae on marginal tuibercle; Wing-vein of fore wing normal, Pts and Rs well developed; SIPH cylindrical sclerotized 0.11-0.17mm long with distinct flange; Cauda knobbed, 0.21-0.23mm with 10-14 setae; Anal plate broadly rounded or slightly bilobed, each side of anal plate with 9-12 setae.

Materials examined. 6 alate viviparous females, Mt. Cheongtaesan, Hoengseong-gun, GW, South Korea, 21.v.2010, Coll 100521HJ-1, on *Betula* sp., H. Kim, CALS SNU; 6 alate viviparous females, SNU, Daehak-dong, Gwanak-gu, Seoul, South Korea, 2.v.2013, Coll 130502YR-1, on *Betula papyrifera*, Y. Lee & H. Lee, CALS SNU; 6 alate viviparous females, SNU, Daehak-dong, Gwanak-gu, Seoul, South Korea, 26.vi.2013, Coll 130626YR-2, on *Betula* sp., Y. Lee & H. Lee, CALS SNU; 1 alate viviparous female, Mt. Eungbongsan, Samcheok-si, GW, South Korea, 4.vi.2014, Coll 140604YR-21, on *Betula* sp., Y. Lee, CALS SNU; 15 alate viviparous females, Pillyae-vally, Inje-gun, GW, South Korea, 4.vi.2014, Coll 140604YR-34, on *Betula* sp., Y. Lee, CALS SNU; 15 alate viviparous females, Hwacheon-gun, GW, South Korea, 17.v.2015, Coll 150517YR-1, on *Betula* sp., Y. Lee & H. Lee, CALS SNU.

Host plant. Betula spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle, on underside of leaves.

Distribution. Korea, Canada, USA.

Remarks. This species is new to Korea. Blackman (2002) described this species based on North American specimens. This species is one of the most common species in Korea.

Euceraphis punctipennis (Zetterstedt, 1840) 가루알락진딧물 (신칭)

Aphis punctipennis Zetterstedt, 1840: 311.

Aphis discolor Burmeister, 1835: 94.

Aphis nigritarsis von Heyden, 1837: 299.

Aphis betulae Walker, 1848: 177; 1852: 936.

Aphis cerasicolens Fitch, 1851: 65.

Callipterus bicolor Koch, 1855: 212.

Euceraphis punctipennis Walker, 1870: 2001; Hille Ris Lambers, 1952: 21; Börner, 1952: 57; Hille Ris Lambers, 1955: 16; Eastop, 1966: 510; Higuchi, 1972: 59; Eastop and Hille Ris Lambers, 1976: 76, 194, 241; Remaudière and Remaudière, 1997: 213.

Aphis cerasicoleus Thomas, 1877: 158.

Myzocallis betularius Schouteden, 1906: 211.

Euceraphis betula Wilson, 1915: 84.

Diagnosis. This species is morphologically close to *E. punctipennis* but can be distinguished by having dark markings on head and Ant.VIb 2.14-2.47 times as long as URS.

Description. Alate viviparous females. Color in iife. Not available. *Morphology* (Table S13; Fig. S13). Body elongated oval, 3.44-3.77mm long; Head slightly wrinkled with dark markings, Y shaped epicranial suture well developed, antennal tubercle developed, head dorsum with 0.03-0.04mm of short and pointed setae; Antenna 6-segmented, Ant.I-II faintly imbricated with wax gland pores, distal half of Ant.IV-VI distinctly imbricated, 1.13-1.32 times as long as body length, antennal setae short and pointed, longest setae on Ant.III 0.43-0.67 times as long as BDAnt.III, Ant.III with 15-20 transversely elliptical secondary rhinaria irregulary distributed on basal 1/3 of the segment, ciliated primary rhinaria on Ant.V rounded, primary rhinaria on Ant.VIb longitudinaly elongate, PT 0.62-0.72times as long as Ant.VIb, Ant.VIb with only 1 short and pointed seta; Rostrum not reaching to middle coxae, URS 0.14-0.16mm long with 9-12 accessory setae, 0.64-0.70 times as long as 2HT; Legs long and slender with many hairs, longest setae on HTB 1.17-1.30 times as long as middle width of HTB, hind first tarsal chaetotaxy 8; Dorsal abdominal tergites without transverse sclerotic band, spicules faintly developed, dorsal abdominal tergite VIII with 6-7 setae, abdominal margin without sclerotic patch, spicules faintly developed, bearing 2-6 setae on marginal tuibercle; Wing-vein of fore wing normal, Pts and Rs well developed, Pts slightly darker; SIPH cylindrical sclerotized 0.11-0.15mm long with distal flange, spicules slightly developed; Cauda knobbed, 0.15-0.24mm with 10-12 setae; Anal plate broadly rounded or slightly bilobed, each side of anal plate with 10-12 setae.

Materials examined. 4 alate viviparous females, Mt. Baekdusan, YG, North Korea, 15.vi.1987, Coll 87HA2289, *Betula ermanii*, J. Havelka, NAAS; 1 alate viviparous female, Jinbu-ri, Pyeongchang-gun, GW, South Korea 3.vi.1999, Coll 990602SH-27, *Betula platyphylla*, S. Lee, NAAS; 1 alate viviparous female, Guidun-ri, Inje-gun, GW, South Korea, 4.vi.1999, Coll 990602SH-57, *Betula* sp., S. Lee, NAAS.

Host plant. Betula spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle, on underside of leaves.

Distribution. Korea, China, Eastern Siberia, throughout Europe and Canada.

Remarks. This species is widely distributed species through Asia to Europe. Blackman firstly recoeded this species from North America based on karyotype and morphological comparion.

Genus *Neobetulaphis* Basu, 1964 못털자작알락진딧물속 (신칭)

Type species: *Neobetulaphis pusila* Basu, 1964: 226.

Diagnosis. This genus is morphologically similar to *Betulaphis* Glendenning, 1926 but easily recognized by having elongated cauda with distinct constriction at the middle and rectangular tubercles on dorsal abdominal tergites.

Host plant. Alnus spp. (Betulaceae), *Betula* spp.* (Betulaceae) and *Quercus* sp. (Fagaceae).

Distribution. Oriental (South-east Asia), Palearctic region (East Asia).

Remarks. This genus is new to Korea. *Neobetulaphis* is small genus comprising 5 species in the world. All species are associated with *Alnus* spp. and *Betula* spp.. Only one species, *N. chaetosiphon* Quednau & Chakrabarti, 1980 was collected on *Quercus* sp. However, this species is also recorded on Betulaceae.

***Neobetulaphis pusila* Basu, 1964 못털자작알락진딧물 (신칭)**

Neobetulaphis pusilla Basu, 1964: 226; Ghosh, Ghosh and Raychaudhuri, 1971: 50; Eastop and Hille Ris Lambers, 1976: 309; Remaudière and Remaudière. 1997: 213; Qiao and Zhang, 2002: 286.

Diagnosis. This species is easily recognized from congeneric species by having spinal and preural hairs on elevations (in other congeneric species, spinal and pleural hairs never placed on elevations).

Description. Apterous viviparous females. Color in iife. Head greenish yellow to orange, compound eye dark brown; Body yellowish orange mottled dark brown and khaki green; Ant.I-III, pale yellow, Ant.IV- VI slightly darker; Legs pale yellow; SIPH brown; Cauda concolorous with body. *Morphology* (Table S14; Fig. S14). Body oval spindle shaped, 1.59-2.19mm long; Head with 5 pairs of cephalic capitate setae on distinct triangular elevations, head surface distinctly spiculose, epicranial suture developed, antennal tubercle developed; Antenna 6-segmented, about half length of body (0.47-0.62), inner margin of Ant.I distinctly bulging, Ant.I-II slightly imbricated with short capitate setae, Ant.III-VI distinctly imbricated, Ant.III without secondary rhinaria, longest setae on Ant.III 0.33 times as long as BDAnt.III, ciliated primary rhinaria on Ant.V and VI rounded, PT 0.67-0.92 times as long as Ant.VIb, Ant.VIb with 1 seta; Rostrum reaching to middle coxae, URS 0.11-0.12mm long with 3-4 accessory setae, 0.85-1.00 times as long as 2HT; Longest setae on HTB same with a middle width of HTB, hind tarsal chaetotaxy 5; Abdominal tergite distinctly segmented with sclerotic elevations, abdominal margin with brownish scleritc patch with 1 long and conspicuous capitate seta on triangular elevation, dorsal abdomininal tergite I-VI with a pair of capitate spinal setae and a pair of short capitate setae on brownish incomplete transverse sclerotic band, dorsal abdomininal tergite VII with a pair of spinal capitate setae, abdomininal tergite VIII entirely brownish sclerotized with 9-10 of thick capitate setae on elevations, spicules developed on abdomen; SIPH cylindrical shaped 0.08-0.09mm long with moderate flange; Cauda elongated 0.20-0.22mm constriction at the middle bearing 22-34 long and fine setae, spicules developed; Anal plate deeply bilobed, each lobe with 10-17 pointed setae.

Materials examined. 10 Apterous viviparous females, Mt. Hambaeksan, Taebaek-si, GW, South Korea, 8.ix.2013, Coll 130908YR-8, *Betula* sp., Y. Lee & H. Lee, CALS SNU.

Host plant. Alnus spp. and *Betula* spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle, on underside of leaves.

Distribution. Korea, China, India and Turkey.

Remarks. This species is new to Korea. Basu (1968) erected the new genus based on this species from India. Korean specimens slightly differ from original describtion. Korean specimens have orange body color but in original description, this species have yellowish green with dark green band in life. It can be a seasonal variation because Korean specimens collected in the fall. Additionally, Korean specimens have same length of tibial setae with middle width of HTB but in original description, tibial setae 1.3 times as long as middle width of HTB. In China, this species was collected on *Alnus* sp. However, in Korea, this species was collected only on *Betula* sp. Alate viviparous females not observed.

Genus *Symydobius* Mordvilko, 1894 털알락진딧물속 (신칭)

Type species: *Aphis oblonga* Von Heyden, 1837: 298.

= *Symydobius oblongus* (von Heyden, 1837).

Diagnosis. This genus is morphologically similar to *Clethrobius* Mordvilko, 1928 but distinguished in having many hairs on Ant.VIb (*Clethrobius* have only 1 seta on Ant.VIb), more abdominal wax glands and tongue shaped cauda (*Clethrobius* have constricted cauda knob).

Host plant. *Alnus* spp.* and *Betula* spp.* (Betulaceae).

Distribution. Nearctic and Palearctic regions.

Remarks. This genus is second largest genus of the subtribe Calaphidina comprising 13 species under 2 subgenera, *Symydobius* Mordvilko and *Yezocallis* Matsumura in the world. *Symydobius* spp. are distributed in temperate zone of Nearctic and Palearctic resion. All species are associated with *Alnus* spp. and *Betula* spp. (Betulaceae). Apterous viviparous females commonly occur.

Key to the subgenera of *Symydobius* Mordvilko in Korea

1. Abdominal tergites without small tubercles .... ***Symydobius***
2. Abdominal tergites with small tubercles .... ***Yezocallis***

Subgenus *Symydobius* Mordvilko, 1894 털알락진딧물아속 (신칭)

Type species: *Aphis oblonga* Von Heyden, 1837: 298.

= *Symydobius oblingus* (von Heyden, 1837).

Mecynaphis Amyot, 1847: 480.

Diagnosis. This subgenus can be recognized from the subgenus *Yezocallis* Mordvilko, 1917 by having small tubercles on abdominal tergite.

Host plant. Alnus spp.* and *Betula* spp.* (Betulaceae).

Distribution. Nearctic and Palearctic regions.

Remarks. This subgenus comprises 9 species mostly distributed in East-Asia and North America. All species feed on plants in Betulaceae.

Symydobius (_Symydobius_) _minutus_ Quednau & Shaposhnikov, 1988

작은털알락진딧물 (신칭)

Symydobius minutus Quednau and Shaposhinikov, 1988: 1024; Remaudière and Remaudière, 1997: 214.

Diagnosis. This species is morphologically similar to *S.* (*S.*) *alniarius* (Matsumura, 1917). However, it can be distinguished by having relatively sparse hairs on Ant.VIb, abdominal tergites VI and VII, *S.* (*S.*) *minutus* also differ in having 31-37 secondary rhinaria on Ant.III in alatae (*S.* (*S.*) *alniarius* has 60-70 secondary rhinaria).

Description. Apterous viviparous females. Color in iife. Not available. *Morphology* (Table S15; Fig. S15). Body oval spindle shaped, 2.40-3.64mm long; Head smooth with many hairs, epicranial suture slightly developed, antennal tubercle poorly developed; Antenna 6-segmented, hairy, 0.62-0.81 times as long as body length, Ant.I-II slightly imbricated, Ant.III-VI imbricated, Ant.III with 12-23 small sized transversely elliptical secondary rhinaria in a row on basal 3/5, primary rhinaria on Ant.V slightly elongated, primary rhinaria on Ant.VIb ciliated longitudinaly elongate, PT 0.60-0.83 times as long as Ant.VIb, Ant.VIb with 7-9 long ans fine setae; Rostrum not reaching to middle coxae, URS 0.13-0.15mm long with 16-20 accessory setae, 0.67-0.83 times as long as 2HT; Legs stout and hairy, longest setae on HTB 0.89-1.25 times as long as middle width of HTB, hind first tarsal chaetotaxy 7; Abdomen with dense hairs, spicules faintly developed, abdominal margin slightly sclerotized, marginal tubercles not developed, dorsal abdominal tergites I-VIII with brownish transverse sclerotic bands, abdominal tergite VIII with 8 spinal setae; SIPH sclerotic, short cylindrical shaped 0.02-0.06mm long with 5-6 setae; Cauda broadly rounded 0.07-0.10mm with 24-28 long and fine setae; Anal plate broadly rounded with 58-68 setae.

Alate viviparous females. *Morphology* (Table S15; Fig. S15-2). Body elongated oval, 3.48-3.69mm long; Head slighlty wrinkled with many hairs, Y shaped epicranial suture well developed, antennal tubercle poorly developed; Antenna 6-segmented, hairy, 0.63-0.77 times as long as body length, wax gland pore developed on Ant.I, Ant.I-III slightly imbricated, Ant.IV-VI imbricated, Ant.III with 31-37 transversely elongated elliptical secondary rhinaria in a row on basal 5/6, ciliated primary rhinaria on Ant.V rounded, on Ant.VIb longitudinaly elongate, PT 0.56-0.64 times as long as Ant.VIb, Ant.VIb with 5-10 long and fine setae; Rostrum not reaching to middle coxae, URS 0.13-0.15mm long with 12-17 accessory setae, 0.67-0.78 times as long as 2HT; Abdominal tergite VIII with 8 setae, SIPH sclerotic, short cylindrical shaped 0.06-0.07mm long; Cauda broadly rounded 0.06-0.09mm with 21-26 long and fine setae; Anal plate broadly rounded with 59-56 setae. The remainders are same with apterous viviparous females.

Materials examined. 1 apterous viviparous female and 2 alate viviparous females, Suwon, GG, South Korea, 2.vi.1968, Coll 4665, on *Alnus* sp., W.H. Paik, NAAS; 2 apterous viviparous females, Suwon, GG, South Korea, 15.x.1968, Coll 4698, on *Alnus* sp., W.H. Paik, NAAS; 1 alate viviparous female, Suwon, GG, South Korea, 19.v.1968, Coll 4554, on *Alnus* sp., W.H. Paik, NAAS; 6 apterous viviparous females, Gwangreung, Pocheon-si, GG, South Korea, 19.ix.1971, Coll 6720, on *Alnus* sp., W.H. Paik, NAAS.

Host plant. Alnus spp.* and *Betula* spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle, on bark, branches and twigs. Often ant-attended.

Distribution. Korea, China, Japan and Eastern Siberia.

Remarks. This species was described as *Symydobius* sp. and *Symydobius oblongus* (von Heyden, 1837) by Paik (1972), and later Quednau and Lee (2001) identified Paik’s specimens as *S.* (*S.*) *minutus*.

Subgenus *Yezocallis* Matsumura, 1917 자작나무털알락진딧물아속 (신칭)

Type species: *Yezocallis kabae* Matsumura, 1917: 353, 369.

Antisymydobius Qiao & Zhang, 2002: 242, 243.

Diagnosis. This subgenus can be recognized from the subgenus *Symydobius* Mordvilko, 1894 by having no tubercles on abdominal tergite.

Host plant. Alnus spp. and *Betula* spp.* (Betulaceae).

Distribution. Palearctic regions.

Remarks. This subgenus comprises 4 species distributed only in East-Asia. Qiao and Zhang (2002) erected subgenus *Antisymydobius*, which becomes a junior synonym of *Yezocallis*.

Symydobius (_Yezocallis_) _kabae_ (Matsumura, 1917) 자작나무털진딧물

Yezocallis kabae Matsumura, 1917: 363, 369.

Symydobius kabae Tao, 1964: 216; Higuchi, 1972: 69; Quednau, 1979: 504; Remaudière and Remaudière, 1997: 214.

Symydobius (*Antisymydobius*) *kabae* Qiao and Zhang, 2002: 245.

Symydobius (*Yezocallis*) *kabae* (Matsumura, 1917): Favret, 2017.

Diagnosis. This species is morphologically similar to *S.* (*Y.*) *paucisensorius* Zhang & Zhang but differ in having 16-30 secondary rhinaria on Ant.III in apterae (*S.* (*Y.*) *paucisensorius* has 1-6 secondary rhinaria on Ant.III in apterae).

Description. Apterous viviparous females. Color in iife. Head and thorax dark brown, compound eye red; Body brown with dark transverse markings; Ant.I-III dark except basal part of Ant.III, distal half of Ant.IV and V, Ant.VI dark brown; Legs entirely dark; SIPH and cauda dark sclerotized. *Morphology* (Table S16; Fig. S16). Body oval spindle shaped with 2.38-2.84mm long; Head slightly wrinkled with dense hairs, spicules conspicuously developed, epicranial suture slightly developed, antennal tubercle poorly developed; Antenna 6-segmented, hairy, 0.88-0.96 times as long as body length, Ant.I-III spiculose, inner margin of Ant.I slightly bulging, Ant.III-VI imbricated, Ant.III with 10-22 small sized transverse elliptical secondary rhinaria distributed in a middle part, ciliated primary rhinaria on Ant.V rounded, on Ant.VIb longitudinaly elongated, PT 0.63-0.78 times as long as Ant.VIb, Ant.VIb with 10-16 long and fine setae; Rostrum reaching to middle coxae, URS 0.13-0.14mm long with 16-21 accessory setae, 0.72-0.82 times as long as 2HT; Legs hairy, longest setae on HTB 1.29-1.50 times as long as middle width of HTB, hind first tarsal chaetotaxy 7; Abdomen covered with dense hairs, thorax and abdominal dorsum with small tubercles, spicules distinctly developed, dorsal abdominal tergites I-VIII with brownish transverse sclerotic band, abdominal tergite VIII with 15-22 setae, abdominal margin I-VII with wax gland pores, slightly sclerotized with small marginal tubercles bearing 15-17 setae; SIPH dark sclerotized with spicules, short cylindrical shaped 0.03-0.04mm long, distal flange moderately developed; Cauda broadly rounded 0.09-0.12mm with 30-33 long and fine setae; Anal plate broadly rounded with 32-36 setae.

Alate viviparous females. *Morphology* (Table S16; Fig. S16-2). Body elongated oval, 2.93-3.72mm long; Head slighlty wrinkled with dense hairs, Y shaped epicranial suture well developed, antennal tubercle poorly developed; Antenna 6-segmented, hairy, 0.65-0.78 times as long as body length, inner margin of Ant.I slightly bulging, Ant.I-III slightly imbricated, Ant.IV-VI imbricated, Ant.III with 28-45 transversely elongated secondary rhinaria in a row on basal 2/3, ciliated primary rhinaria on Ant.V rounded, on Ant.VIb longitudinaly elongate, PT 0.57-0.74 times as long as Ant.VIb, Ant.VIb with 12-13 long and fine setae; Rostrum not reaching to middle coxae, URS 0.13-0.15mm long with 18-25 accessory setae, 0.72-0.83 times as long as 2HT; Abdominal tergite VIII with 13-24 setae, abdominal margin I-VII with wax gland pores, sclerotized with small marginal tubercles bearing 21-28 setae; SIPH short 0.02-0.03mm long; Cauda broadly rounded 0.07-0.09mm with 13-21 long and fine setae; Anal plate broadly rounded with 59-74 setae. The remainders are same with apterous viviparous females.

Materials examined. 1 apterous viviparous female, Daegwanryeon-myeon, Pyeongchang-gun, GW, South Korea, 12.viii.1963, Coll 1341, on *Betula platyphylla*, W.H. Paik, NAAS; 1 apterous viviparous female, Yeoju-si, JN, South Korea, 16.viii.1963, Coll 1433, on *Betula platyphylla* (var. *latifoliae*), W.H. Paik, NAAS; 1 alate viviparous female, Daegwanryeon-myeon, Pyeongchang-gun, GW, South Korea, vi.1968, Coll 286, yellow pan trap, W.H. Paik, NAAS; 2 apterous viviparous females, Ansung-myeon, Muju-gun, JB, South Korea, 27.vii.1969, Coll 5183, host plant unknown, W.H. Paik, NAAS; 2 alate viviparous females, Danyang-gun, CB, South Korea, 1-10.viii.1969, Coll 5305, on *Betula costata*, W.H. Paik, NAAS; 3 apterous viviparous females, Danyang-gun, CB, South Korea, 24-30.viii.1969, Coll 5387, on *Betula costata*, W.H. Paik, NAAS; 3 alate viviparous females, Daegwanryeon-myeon, Pyeongchang-gun, GW, South Korea, 11-20.vii.1971, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 3 apterous viviparous females, Samjiyeon-pond, Mt. Baekdusan, YG, North Korea, 12.vii.1987, Coll 87HA2232, on *Betula ermanii*, J. Havelka, NAAS;

2 apterous viviparous females and 2 alate viviparous female, Gyeongseong-gun, HB, North Korea, 19.vi.1987, Coll 88HA1887, on *Betula davurica*, J. Havelka, NAAS; 1 alate viviparous female, Mt. Baekdusan, YG, North Korea, 29.vi.1988, Coll 88HA3218, on *Betula costata*, J. Havelka, NAAS; 3 alate viviparous females, Mt. Baekdusan, YG, North Korea, 29.vi.1988, Coll 88HA3406, on *Betula costata*, J. Havelka, NAAS; 5 apterous viviparous females, Jinan-gun, JB, South Korea, 20.vi.2000, Coll 000620SH-24, on *Betula platphylla*, S. Lee, NAAS; 10 apterous viviparous females and 2 alate viviparous females, Deokpyeong-service area, Icheon-si, GG, South Korea, 30.vi.2014, Coll 140630YR-8, on *Betula pendula*, Y. Lee, CALS SNU.

Host plant. *Alnus* spp. and *Betula* spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle, on bark, branches and twigs. Often ant-attended.

Distribution. Korea, China, Japan, Mongolia and Eastern Siberia.

Remarks. This species is widely distributed across Manturian region. In Mongolia, this species was also collected on *Alnus* spp. But in Korea, this species was only collected on *Betula* spp.

Subtribe Monaphidina Baker, 1920 더듬이긴알락진딧물아족 (신칭)

Type genus: *Monaphis* Walker, 1870: 2001.

Genus *Monaphis* Baker, 1870 더듬이긴알락진딧물속 (신칭)

Type species: *Aphis antennata* (Kaltenbach, 1843): 115.

= *Monaphis antennata* (Kaltenbach, 1843).

Bradyaphis Mordvilko, 1894: 59.

Diagnosis. This genus is recognized by having cilia-less primary rhinaria, Ant.III covered with irregulary scattered secondary rhinaria over whole surface and elongated black Pts.

Host plant. Betula spp.* (Betulaceae).

Distribution. Nearctic and Palearctic regions.

Remarks. This genus is new to Korea. *Monaphis* is monotypic genus represented by a single species *M. antennata* (Kaltenbach). This species is extremely rare and always found at low densities on birch trees. Apterous viviparous female unknown.

Monaphis antennata (Kaltenbach, 1843) 더듬이긴알락진딧물 (신칭)

Aphis antennata Kaltenbach, 1843: 115; Walker, 1848: 330; Kaltenbach, 1874: 610;

Monaphis antennata Walker, 1870: 2001; van der Goot, 1915: 340; Börner, 1952: 59; Higuchi, 1972: 63; Eastop & Hille Ris Lambers, 1976: 42, 286; Remaudière & Remaudière, 1997: 213.

Bradyaphis antennata Schouteden, 1906: 212; Mordvilko, 1909: 375.

Diagnosis. This species is easily recognized by having well developed long and thick blackish antennae and well developed elongate dark Pts of fore wing.

Description. Alate viviparous females. Color in iife. Whole body yellow to yellowish green; Compound eye red; Ant.I-II pale, Ant.III-VI black except for basal part of Ant.III and distal half of PT. Tibiae and 2HT black, distal half of femur dark; SIPH and cauda concolorous with body. *Morphology* (Table S17; Fig. S17). Body oval, flattened ventrally, 3.00-4.14mm long; Head slightly wrinkled with minute hairs, epicranial suture distinctly developed, antennal tubercle well developed, clypeus, and its surrounded area corrugated; Antenna 6-segmented, 1.31-1.87 times as long as body length, Ant.I with faintly corrugated, Ant.III covered with 46-57 rounded secondary rhinaria irregulary scattered over whole surface, cilia-less primary rhinaria on Ant.V and VI rounded, PT and Ant.VIb inconspicuously segmented, PT very long, 8.18-10.59 times as long as Ant.VIb, Ant.VIb with 3-5 short setae; Rostrum not reaching to middle coxae, URS 0.15-0.18mm long with 6-8 accessory setae, slightly shorter or almost same length with 2HT, (URS 0.83-1.06 times as long as 2HT); Longest setae on HTB short, 0.28-0.39 times as long as middle width of HTB, hind first tarsal chaetotaxy 9; Abdomen flattend centrally, abdominal dorsum corrugated, abdominal setae numerous and inconspicuous, abdominal tergite VIII with 12-14 setae, abdominal margin I-VII with well developed tubercles, 4th marginal tubercle with 6-10 short setae; SIPH short, 0.02-0.04mm long with moderate distal flange; Cauda knobbed, 0.19-0.26mm with 7-10 long and fine setae; Anal plate bilobed, each lobe with 14-18 setae.

Materials examined. 9 alate viviparous females, Haesanryeong rest area, Hwacheon-gun, GW, South Korea, 30.v.2015, Coll 150530YR-1, on *Betula schmidtii*, Y. Lee & H. Lee, CALS SNU.

*Host plant. Betula schmidtii** (Betulaceae).

Biology. Monoecius holocyclic lifecycle. Feeding location of nymphs restricted on the upper side of leaves and leaf petioles. In the final moult, they migrate to the underside of the leaves. Live solitarily and show a tendency to make a small colony only with one or a few females and their offspring.

Distribution. Korea, China, Japan, Eastern Siberia, across Europe, recently introduced into Canada and USA.

Remarks. This species is new to Korea. *M. antennata* was originally described from Palearctic region but recently also recorded from North America. In Korea, this species was only collected on *Betula schmidtii* (Betulaceae).

Tribe Panaphidini Oestlund, 1923 애알락진딧물족

Subtribe Myzocallidina Passerini, 1860 낙타진딧물아족

Type genus: *Myzocallis* Passerini, 1860: 28.

Genus *Tuberculatus* Mordvilko, 1894 낙타진딧물속

Type species: *Aphis quercea* Kaltenbach, 1843: 136.

= *Tuberculatus querceus* (Kaltenbach, 1843).

Camelaphis Hille Ris Lambers, 1974: 24.

Diagnosis. This genus is recognized by having cone shaped, cylindrical, finger like conspicuous tubercles on dorsal abdominal tergite I-III, marginal tubercles usually well depeloped, Ant.III with rounded secondary rhinaria.

Host plant. Castanea spp.*, *Lithocarpus* spp. and *Quercus* spp.* (Fagaceae).

Distribution. Nearctic, Neotropical and Palearctic, introduced into Australasian region.

Remarks. This genus is the largest genus comprising 58 species of 10 subgenera in the world. *Tuberculatus* species are originally distributed across Europe, Asia, North and South America but recently, some species were introduced into Australia and New Zealand. Most species are associated with *Quercus* spp. (Fagaceae). Often ant attendece. Flight ability of alate viviparous females can be differ according to ant attendance induced reduction of flight ability. Apterous viviparous female unknown.

Key to the subgenera of *Tuberculatus* Mordvilko in Korea

1. Dorsal abdominal tubercles without distinctly developed............. ***Nippocallis***

- Dorsal abdominal tubercles cone or finger like shaped, usually on abdominal tergite I-III **2**

2. Thorax without spinal tubercles, head, thorax and hind leg entirely blackish ....***Arakawana***

- Thorax with or without spinal tubercles, head, thorax and hind leg not entirely blackish... **3**

3. Mesonotum never with spinal tubercles, dorsal abdominal tubercles rarely dark stlerotized, Pts of fore wing clear without dark markings.. ***Orientuberculoides***

- Mesonotum with or without spinal tubercles, dorsal abdominal tubercles usually dark stlerotized, Pts of fore wing clear with dark markings **4**

4. Head vertex and thorax dark, fore wing with scattered setae.. ***Acanthocallis***

- Head vertex and thorax pale, fore wing never with setae .... ***Acanthotuberculatus***

Subgenus *Acanthocallis* Matsumura, 1917 낙타진딧물아속 (신칭)

Type species: *Acanthocallis quercicola* Matsumura, 1917: 353, 367.

Diagnosis. This subgenus is morphologically similar to the subgenus *Acanthotuberculatus* Quednau but differ in having dark head vertex and thorax, scattered setae developed on fore wing.

Host plant. Quercus spp.* (Fagaceae).

Distribution. Palearctic region.

Remarks. This subgenus comprises 6 species which are only distributed in East-Asia (Korea, China, Japan and Eastern Siberia). All species are associated with *Quercus* spp. (Fagaceae) and ant attended. Each species is highly host specific.

Key to the species of *Acanthocallis* Matsumura in Korea

1. Ant.III with 7-9 secondary rhinaria, URS 2.0-2.1mm long................................ .... ***T.* (*A.*) *macrotuberculatus***

- Ant.III with 4-6 secondary rhinaria, URS 0.13-0.15mm long **2**

2. Antennal setae relatively sparse, Ant.III with 10-14 setae, Ant.IV-V with 3-5 setae .... ***T.* (*A.*) *quercicola***

- Antennal setae relatively dense, Ant.III with 14-17 setae, Ant.IV-V with 6-9 setae .... ***T.* (*A.*) *alienae* sp. nov.**

***Tuberculatus* (*Acanthocallis*) *alienae* Lee, sp. nov.** 갈참낙타진딧물 (신칭)

Diagnosis. This species is superficially similar to *T*. (*A*.) *quercicola* but can be distinguished by having more hairs on Ant.III (14-17 setae in *T*. (*A*.) *alienae*, 10-14 hairs in *T*. (*A*.) *quercicola*) and Ant.IV-V (6-9 setae in *T*. (*A*.) *alienae*, 3-5 hairs in *T*. (*A*.) *quercicola*).

Description. Alate viviparous female. Color in iife. Head and thorax green with dark markings, compound eye pale red; Ant.I-II pale, Ant.III-VIb pale with dark distal joint, PT dark; Body green to bluish green, abdominal dorsum and margin with dark sclerotized, dorsal abdominal tubercles dark; Tibiae pale, fore femur pale, middle and hind femur dark except basal 1/4, distal tarsus dark; Wing vein of fore wing dark bordered; Cauda and SIPH concolorous with body. *Morphology* (Table S18; Fig. S18). Body oval, 1.76-2.23mm long; Head wrinkled with 0.12-0.14mm long and fine seate on small elevations, epicranial suture not developed, antennal tubercle well developed; Antenna 6-segmented, 0.70-0.84 times as long as body length, inner distal margin of Ant.I bulging, Ant.I-IV slightly imblicated, Ant.V-VI imblicated, antennal setae long and fine, Ant.III with 5-6 rounded secondary rhinaria in a row on basal 2/3, longest setae on Ant.III 3.00-4.50 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT 0.94-1.27 times as long as Ant.VIb, Ant.VIb with 0.03-0.06mm of 1-2 and rarely 3 long and fine setae; Rostrum not reaching to middle coxae, URS 0.13-0.14mm long with 10-14 accessory setae, almost same length with 2HT, (URS 1.00-1.17 times as long as 2HT); Longest setae on HTB 2.00-3.00 times as long as middle width of HTB, hind first tarsal chaetotaxy 8; Pronotum with 2 pairs of tubercles; Mesonotum without tubercles; Abdominal dorsum I-IV with a pair of pigmented tubercles, tubercles on abdominal dorsum III broadly fused basally, 0.08-0.14mm long bearing 6-7 long and pointed setae, abdominal tergite VIII with 8-12 spinal setae, abdominal margin I-V with 2-8 long andfine setae on well developed pigmented tubercles, wax gland pores and spicules developed on marginal tubercle; SIPH short cylindrical, 0.07-0.09mm long with distal flange; Cauda knobbed, 0.12-0.17mm with 17-22 long and fine setae; Anal plate bilobed, each lobe with 16-22 setae.

Types. Holotype. 1 alate viviparous female, Yongmun-recreation forest, Yangpyeong-gun, GG, South Korea, 13.vii.2013, Coll 130713YR-7, on *Quercus aliena*, Y. Lee & H. Lee, CALS SNU; Paratypes. 12 alate viviparous females, Nam-myeon, Yangju-si, GG, South Korea, 21.vii.2008, Coll 080721HJ-15, on *Quercus aliena*, H. Kim, CALS SNU; 9 alate viviparous females, Mt. Taehwasan, Gwangju-si, GG, South Korea, 16.vi.2012, on *Quercus aliena*, H. Choi, CALS SNU, 35 alate viviparous females, same data as the holotype.

*Host plant. Quercus aliena** (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On upperside of leaves and leaf petioles. Often ant-attended.

Distribution. Korea.

Etymology. The species name *alienae* is derived from host plant name *Quercus aliena*.

Remarks. This species is newly recognized from Korea. Although this species is superficially similar to congeneric species, its host plant association is distinct to other species.

***Tuberculatus* (*Acanthocallis*) *macrotuberculatus* (Essig & Kuwana, 1918)**

큰혹낙타진딧물 (신칭)

Myzocallis macrotuberculata Essig and Kuwana, 1918: 90.

Tuberculatus (*Tuberculatus*) *quercicolus* Richards, 1968: 584.

Tuberculatus quercicola Higuchi, 1969: 117; 1972: 48.

Tuberculatus (*Acanthocallis*) *quercicola* Eastop and Hille Ris Lambers, 1976: 291; Remaudière and Remaudière, 1997: 228.

Tuberculatus macrotuberculatus Watanabe, Yao and Akimoto, 2015: 60.

Diagnosis. This species is morphologically similar to *T.* (*A.*) *quercicola* (Matsumura, 1917) but differ in having 7-9 secondary rhinaria on Ant.III (in *T.*

(*A.*) *quercicola*, 4-5), and longer legth of URS, 0.2-0.21mm long (in *T.* (*A.*) *quercicola*, 0.13-0.15mm long).

Description. Alate viviparous female. Color in iife. Head yellowish green, thorax yellowish green with dark markings, compound eye pale red; Ant.I-II pale, Ant.III-IVb pale with dark distal joint, distal half of PT dark; Body yellowish green to gree with dark abdominal dorsal tubercles; Tibiae pale, fore femur pale, middle and hind femur and tarsus dark except basal part; wing vein dark bordered; Cauda and SIPH concolorous with body. *Morphology* (Table S19; Fig. S19). Body oval, 2.37-2.93mm long, Head wrinkled with 0.10-0.14mm long and fine seate on small elevations, epicranial suture not developed, antennal tubercle well developed; Antenna 6-segmented, 0.58-0.65 times as long as body length, inner margin of Ant.I slightly bulging, Ant.I-IV slightly imblicated, Ant.V-VI imblicated, antennal setae long and fine, 7-9 rounded secondary rhinaria in a row on Ant.III, longest setae on Ant.III 2.67-3.00 times as long as BDAnt.III, some specimen rarely have 1 secondary rhinaria on Ant.IV, Ant.V and VI with ciliated rounded primary rhinaria each, PT 0.81-1.00 times as long as Ant.VIb, Ant.VIb with 0.04-0.06mm of 2-3 long and fine setae; Rostrum barely reaching to middle coxae, URS 0.20-0.21mm long with 13-15 accessory setae, 1.40-1.57 times as long as 2HT; Tibial setae long and fine, 1.80-2.40 times as long as middle width of HTB, hind first tarsal chaetotaxy 8; Pronotum with 2 pairs of tubercles; Mesonotum with a pair of tubercles; Abdominal dorsum I-IV with a pair of tubercles, tubercles on abdominal dorsum I and IV poorly developed, abdominal tergite VIII with 6-8 spinal setae, tubercle on abdominal dorsum II-III broadelly fused basally, 0.11-0.17mm long with 5-8 long and fine setae, tubercles spiculose, abdominal margin with 2-6 long and fine setae on well developed pigmented tubercles, 4th marginal tubercle with 8-9 setae, wax gland pores and spicules developed on marginal tubercles; SIPH short cylindrical, 0.09-0.11mm long with distal flange, spicules developed; Cauda knobbed, 0.14-0.15mm with 19-23 long and fine setae; Anal plate bilobed, each lobe with 21-22 setae.

Materials examined. 2 alate viviparous females, Mt. Geumgangsan, Onjong-ri, North Korea, 5.vi.1987, Coll 85HA1713, on *Quercus dentata*, J. Havelka, NAAS; 17 alate viviparous females, Mt. Cheongryongsan, Pyeongseong-gun, PN, North Korea, 3.vii.1988, Coll 88HA3496, on *Quercus dentata*, J. Havelka, NAAS; 7 alate viviparous females, Taean-gun, CN, South Korea, 10.v.2014, Coll 140510YR-18, on *Quercus dentata*, Y. Lee & H. Lee, CALS SNU.

*Host plant. Quercus dentate** (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves and leaf petioles. Often ant-attended.

Distribution. Korea and Japan.

Remarks. This species is new to Korea. *T*. (*A*.) *macrotuberculatus* was synonymized into closely related species *T.* (*A.*) *quercicola* by Higuchi (1969). However, recently Watanabe et al. (2015) revived this species based on different host plant association and molecular phylogeny.

***Tuberculatus* (*Acanthocallis*) *pappus* Zhang, Zhang & Zhong, 1990**

Tuberculatus pappus Zhang, Zhang & Zhong, 1990: 101, 108, 117.

Tuberculatus (*Acanthocallis*) *pappus* Quednau, 1997: 228; Remaudière & Remaudière, 1997: 228, 229; Quednau, 1999: 42; Quednau, 2003: 293, 296.

Tuberculatus (*Acanthocallis*) *quercus* Blackman, 2015.

Remarks. This is synonym of *Tuberculatus* (*Acanthocallis*) *quercicola* Matsumura, 1917 (Blackman, 2015).

***Tuberculatus* (*Acanthocallis*) *quercicola* Matsumura, 1917 낙타진딧물**

Acanthocallis quercicola Matsumura, 1917: 353, 367.

Myzocallis quercicola Takahashi, 1923: 64, 212.

Tuberculatus quercicola Tseng and Tao, 1938: 212; Hille Ris Lambers, 1974: 24; Higuchi, 1969: 117.

Tuberculatus (*Tuberculatus*) *quercicolus* Richards, 1968: 584: 1969: 52.

Tuberculatus (*Acanthocallis*) *quercicola* Eastop and Hille Ris Lambers, 1976: 10; Quednau, 1979: 505; Quednau and Shaposhnikov, 1988: 1026; Remaudière and Remaudière, 1997: 228; Quednau, 1999: 42.

Diagnosis. This species is morphologically almost indistinguishable with *T*. (*A*.) *alienae* **sp. nov.** This species is only differ in having less hairs on Ant.III (14-17 setae in *T*. (*A*.) *alienae*, 10-14 hairs in *T*. (*A*.) *quercicola*) and Ant.IV-V (6-9 setae in *T*. (*A*.) *alienae*, 3-5 hairs in *T*. (*A*.) *quercicola*).

Description. Alate viviparous female. Color in iife. Head dusky yellowish brown, thorax brownish with dark markings, compound eye pale red;

Ant.I-II pale, Ant.III-VIb pale with dark distal joint, distal part of PT dark; Body yellowish brown to orange brown with dark abdominal dorsal tubercles; Tibiae pale, fore and middle femur pale, hind femur and tarsus dark except basal part; wing vein dark bordered; Cauda and SIPH concolorous with body. *Morphology* (Table S20; Fig. S20). Body oval, 2.10-2.35mm long; Head wrinkled with 0.10-0.13mm long and fine seate on small elevations, epicranial suture not developed, antennal tubercle developed; Antenna 6-segmented, 0.61-0.65 times as long as body length, inner margin of Ant.I bulging, Ant.I-III slightly imblicated, Ant.IV-VI imblicated, antennal setae long and fine, Ant.III 4-5 rounded secondary rhinaria in a row on middle part, Ant.V and VI with ciliated rounded primary rhinaria each, PT 1.00-1.13 times as long as Ant.VIb, Ant.VIb with 0.03-0.04mm of 1-2 long and fine setae; Clypeus corrugated, rostrum reaching to middle coxae, URS 0.13-0.15mm long with 9-11 accessory setae, 0.93-1.25 times as long as 2HT; Longest setae on HTB 1.60-2.75 times as long as middle width of HTB, hind first tarsal chaetotaxy 8; Pronotum with 2 pairs of tubercles, mesonotum with a pair of small tubercles; Abdominal dorsum I-V with a pair of tubercles, tubercles on abdominal dorsum I, IV and V poorly developed without pigmentation, tubercles on abdominal dorsum II-III broadly fused bsally, 0.09-0.14mm long with 5-6 long and pointed setae, abdominal tergite VIII with 6-10 spinal setae, abdominal margin I-V with well developed pigmented tubercles, 4th marginal tubercle with 7-9 setae; SIPH short 0.07-0.08mm long with distal flange; Cauda knobbed, 0.14-0.17mm with 18-22 long and fine setae; Anal plate bilobed, each lobe with 17-21.

Materials examined. 19 alate viviparous females, Seoul National Univ., Gwanak-gu, Seoul, South Korea, 16.xi.2013, Coll 130916YR-3, on *Quercus mongolica*, Y. Lee & H. Lee, CALS SNU.

Biology. Monoecius holocyclic lifecycle. On upperside of leaves and leaf petioles. Often ant-attended.

Host plant. Quercus mongolica spp.* (Fagaceae).

Distribution. Korea, China, Japan and Eastern Siberia.

Remarks. Identification of this group of species is very difficult due to their morphological similarity. According to Watanabe et al. (2015), this group of species are highly host specific. In Japan, *T.* (*A.*) *quercicola* occurs only on *Quercus mongolica* spp. *crispula*.

Subgenus *Acanthotuberculatus* Quednau, 1999 혹낙타진딧물아속 (신칭)

Type species: *Tuberculatus japonicus* Higuchi, 1969: 112, 114.

Diagnosis. This subgenus is morphologically similar to the subgenus *Acanthocallis* but can be distinguished by pronotum always with 2 pairs of finger like spinal tubercle, fore wing without scattered setae.

Host plant. Quercus spp.* (Fagaceae).

Distribution. Palearctic region.

Remarks. This subgenus comprises 4 species distributed in Asia (Korea, China, India and Japan). All species are associated with *Quercus* spp. (Fagaceae) and attended by ant.

Key to the species of *Acanthtuberculatus* Higuchi in Korea

1. Setae on head and antenna capitated, metanotum with a pair of finger like tubercle .... ***T.* (*A.*) *japonicus***

- Setae on head and antenna pointed or blunted shape, metanotum without finger like tubercle **2**

2. Ant.II 0.05-0.07mm, Ant.IV 0.23-0.39mm, SIPH 0.10-0.13mm long .... ***T.* (*A.*) *acutissimae* sp. nov.**

- Ant.II 0.07-0.09mm, Ant.IV 0.33-0.41mm, SIPH 0.13-0.15mm long .... ***T.* (*A.*) *indicus***

***Tuberculatus* (*Acanthotuberculatus*) *acutissimae* Lee, sp. nov. 혹낙타진딧물 (신칭)**

Diagnosis. This species is morphologically similar to *T.* (*A.*) *indicus* Gosh, 1972 but can be recognized by having shorter length of antenna and SIPH, longest setae on cauda 0.08-0.13mm.

Description. Alate viviparous female. Color in iife. Head yellowish green to redish brown, thorax yellowish green or redish brown with witish tubercles, compound eye pale; Ant.I-II pale, Ant.III-IVb pale with dark distal joint; Body yellowish green to redish brown with pale and dark abdominal dorsal tubercles; Tibiae pale, middle and fore femur pale, hind femur and distal part of tarsus dark; Pts, basal cu-1b, cu1a and m of fore wing dark bordered; Cauda and

SIPH concolorous with body. *Morphology* (Table S21; Fig. S21). Body oval, 1.56-2.58mm long; Head wrinkled with 0.10-0.14mm long and blunted seate on small elevations, epicranial suture not developed, antennal tubercle well developed; Antenna 6-segmented, 0.71-0.79 times as long as body length, inner margin of Ant.I bulging, Ant.I-II slightly imblicated, Ant.IV-VI imblicated, Ant.I-V with long and blunted setae, Ant.III with 3-8 rounded secondary rhinaria in a row on basal 2/3, longest setae on Ant.III 1.33-2.33 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT 1.11-1.50 times as long as Ant.VIb, Ant.VIb with only 1 invisible seta; Rostrum not reaching to middle coxae, URS 0.11-0.14mm long with 7-9 accessory setae, 0.92-1.22 times as long as 2HT; Tibial setae long and fine, 1.40-1.75 times as long as middle width of HTB, hind first tarsal chaetotaxy 8; Pronotum with two pairs of finger like tubercles, mesonotum with a pair of finger like tubercle, metanotum without tubercles; Abdominal dorsum I-IV with a pair of well developed finger-like tubercles, tubercles on abdominal dorsum II and III pigmented, tubercles on abdominal dorsum IV poorly developed, longest tubercle on abdominal dorsum III, 0.17-0.29mm long with 3-5 pointed setae, abdominal tergite VIII with 4-8 spinal setae, abdominal margin I-VIII with 3-7 pointed or blunted setae on well developed marginal tubercles, wax gland pores developed; SIPH cylindrical spiculose, 0.10-0.13mm long with distal flange, often pigmented; Cauda knobbed, 0.12-0.16mm with 14-17 long and fine setae; Anal plate bilobed, each lobe with 13-17 setae.

Types. Holotype. 1 alate viviparous female, Anseong-si, GG, South Korea, 23.v.2015, Coll 150523YR-2, on *Quercus acutissima*, Y. Lee, CALS SNU;

Paratypes. 1 alate viviparous female, Cheongwan-recreation forest, 15.v.2009, Coll 090515SH-16, S. Lee, on *Quercus acutissima*, Y. Lee, CALS SNU; 4 alate viviparous females, Ewha Woman's University, Seoul, South Korea, 26.iv.2013, Coll 130512YR-12, on *Quercus acutissima*, Y. Lee & H. Lee, CALS SNU; 6 alate viviparous females, Chusan-research forest, Gwangyang-si, JN, South Korea, 24.vii.2013, 130724YR-5, on *Quercus acutissima*, Y. Lee, CALS SNU; 3 alate viviparous females, Chusan-research forest, Gwangyang-si, JN, South Korea, 25.vii.2013, 130725YR-9, on *Quercus acutissima*, Y. Lee, CALS SNU; 5 alate viviparous females, SNU, Gwanak-gu, Seoul, South Korea, 26.iv.2014, Coll 140426YR-8, on *Quercus acutissima*, Y. Lee, CALS SNU; 10 alate viviparous females, Seonsan-service area, Gumi-si, South Korea, 30.vi.2014, Coll 140630YR-9, on *Quercus acutissima*, Y. Lee, CALS SNU; 1 alate viviparous female, Mt. Hallasan, Jeju-si, JJ, 1.viii.2014, Coll 140801YR-8, on *Quercus acutissima*, Y. Lee, CALS SNU; 4 alate viviparous females, same data as the holotype.

*Host plant. Quercus acutissima** (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On under and upperside of leaves, prefer to feed on leaf veins. Often ant-attended.

Distribution. Korea.

Etymology. The species name *acutissimae* is derived from host plant name *Quercus acutissima*.

Remarks. This species is newly recognized from Korea. Its host plant association seems to be restricted to *Q. acutissima*. Body color is variable in life.

Tuberculatus (_Acanthotuberculatus_) _indicus_ Gosh, 1972 동양혹낙타진딧물 (신칭)

Tuberculatus indicus Gosh, 1972: 301; Chakrabarti, Samiran and Raychaudhuri, 1975: 97; Adachi and Yoshitomi, 2012: 31.
Tuberculatus (*Acanthocallis*) *indicus* Hille Ris Lambers, 1974: 24, 49; Quednau, 1979: 504; Remaudière and Remaudière, 1997: 228.
Tuberculatus (*Acanthotuberculatus*) *indicus* Quednau, 1999: 296; 2003: 296.

Diagnosis. This species is morphologically similar to *T*. (*A*.) *japonicas*. However, it differs in having no tubercles on metanotum.

Description. Alate viviparous female. Color in iife. Not available. *Morphology* (Table S22; Fig. S22). Body oval, 2.45-3.21mm long; Head slightly wrinkled with 0.11-0.13mm long and blunted seate on small elevations, epicranial suture absent, antennal tubercle well developed; Antenna 6-segmented, 0.61-0.71 times as long as body length, inner margin of Ant.I bulging, Ant.I-II slightly imblicated, Ant.IV-VI imblicated, Ant.I-V with blunted setae, Ant.III with 4-8 rounded secondary rhinaria in a row on basal 1/2, longest setae on Ant.III 0.80-1.25 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT 1.05-1.26 times as long as Ant.VIb, Ant.VIb with only 1 almost invisible seta; Rostrum not reaching to middle coxae, URS 0.11-0.13mm long with 7-8 accessory setae, 0.80-1.00 times as long as 2HT; Longest setae on HTB, 1.00-1.40 times as long as middle width of HTB, hind first tarsal chaetotaxy 8; Pronotum with two pairs of well developed spinal tubercles, mesonotum with a pair of spinal tubercle, metanotum without tubercles; Abdominal dorsum I-III with a pair of well developed finger-like tubercles, tubercles on abdominal dorsum II and III pigmented, longest tubercle on abdominal dorsum III, 0.24-0.31mm long, abdominal tergite VIII with 6-7 setae, abdominal margin I-VI with well developed pigmented tubercles bearing 5-7 pointed setae, wax gland pores developed on marginal tubercle; SIPH pigmented cylindrical, 0.13-0.15mm long with distal flange; Cauda knobbed, 0.17-0.19mm with 13-17 long and fine setae; Anal plate bilobed, each lobe with 14-21 setae.

Materials examined. 2 alate viviparous females, Suwon-si, GG, South Korea, 2.v.1967, Coll 4056, on *Quercus aliena*, W.H. Paik, NAAS; 1 alate viviparous female, Seoul, South Korea, 21.v.1968, Coll 4601, on *Quercus celtata*, W.H. Paik, NAAS; 1 alate viviparous female, Seoul, South Korea, 4.xi.1970, Coll 6161, on *Quercus* sp., W.H. Paik, NAAS; 1 alate viviparous female, Mt. Yonggaksan, Pyeongyang-si, North Korea, 14.v.1988, Coll 88HA2439, on *Quercus dentata*, J. Havelka, NAAS; 9 alate viviparous females, Onjeong-ri, Mt. Geumgangsan, North Korea, 27.v.1988, Coll 88HA2626, on *Quercus aliena*, J. Havelka, NAAS; 2 alate viviparous females, Mt. Yeogisan, Suwon-si, GG, 15.x.1998, Coll 981015F-7, on *Quercus dentata*, S. Lee, NAAS; 7 alate viviparous females, Danseong-myeon, Danyang-gun, CB, 18.v.2001, Coll 011517-SH20, on *Quercus* sp., S. Lee, NAAS;

Host plant. Quercus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On underside and upperside of leaves, prefer to feed on leaf veins. Often ant-attended.

Distribution. Korea, China, Japan and India.

Remarks. This species was described by Gosh (1972) based on a single alate specimen from India. Hille Ris Lambers mentioned that specimens from India, Korea and Japan show variable in morphology such as shape of setae.

Tuberculatus (_Acanthotuberculatus_) _japonicus_ Higuchi, 1969

일본낙타진딧물

Tuberculatus japonicus Higuchi, 1969: 112, 114; 1972: 48; Pashtshenko, 1981: 38; Zhang, Zhang and Zhong, 1990: 106.
Tuberculatus (*Acanthocallis*) *indicus* Quednau and Shaposhinikov, 1988: 1026; Remaudière and Remaudière, 1997: 228.
Tuberculatus (*Acanthotuberculatus*) *japonicus* Quednau, 1999: 40; 2003: 159.

Diagnosis. This species is morphologically similar to *T*. (*A*.) *indicus* Gosh but can be recognized by having capitated setae on head and antenna, secondary rhinaria on Ant.III distributed on whole segment, metanotum with a pair of finger like spinal tubercle.

Description. Alate viviparous female. Color in iife. Not available. *Morphology* (Table S23; Fig. S23). Body oval, 2.16-3.06mm long; Head slightly wrinkled with 0.06-0.12mm long and capitate seate on small elevations, epicranial suture not developed, antennal tubercle well developed; Antenna 6-segmented, 0.57-0.83 times as long as body length, inner margin of Ant.I bulging, antennal setae capitated, Ant.I-III slightly imblicated, Ant.IV-VI imblicated, Ant.III with 5-9 rounded secondary rhinaria in a row on whole segment, antennal setae on Ant.I-V capitated, Ant.V and VI with ciliated rounded primary rhinaria each, PT 1.05-1.42 times as long as Ant.VIb, Ant.VIb with only 1 invisible seta; Rostrum not reaching to middle coxae, URS 0.15-0.18mm long with 6-7 accessory setae, 1.14-1.31 times as long as 2HT; Longest setae on HTB 0.83-1.25 times as long as middle width of HTB, first tarsal chaetotaxy 6; Pronotum with two pairs of finer like spinal tubercle, meso and metanotum with a pair of finger like tubercle; Abdominal dorsum I-IV with a pair of well developed finger like tubercles, tubercles on abdominal dorsum II-III pigmented and broadely fused basally, 0.14-0.32mm long with 3-7 blunted setae, tubercles on abdominal dorsum IV poorly developed, abdominal tergite VIII with 4-5 setae, abdominal margins I-VII with 2-6 capitate setae on well developed pigmented tubercles, wax gland pores developed on marginal tubercle; SIPH 0.11-0.15mm long with distal flange; Cauda knobbed, 0.13-0.18mm with 9-15 long and fine setae; Anal plate bilobed, eac lobe with 12-17 setae.

Materials examined. 1 alate viviparous female, Sosa, GG, South Korea, 11-20.v.1970, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Goyang-si, Gygeonggi-do, South Korea, 11-20.v.1970, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Muju, South Korea, 11-20.v.1970, yellow pan trap, W.H. Paik, NAAS; 2 alate viviparous females, Seoul, South Korea, 12.v.1971, Coll 6269-B, on *Quercus dentata*, W.H. Paik, NAAS; 1 alate viviparous female, Suwon-si, GG, South Korea, 28.v.1971, on *Quercus aliena*, W.H. Paik, NAAS; 1 alate viviparous female, Suwon-si, GG, South Korea, 30.v.1971, Coll 6269-B, on *Quercus aliena*, W.H. Paik, NAAS; 10 alate viviparous females, Mt. Yonggaksan, Pyeongyang-si, North Korea, 11.v.1988, Coll 88HA2968, on *Quercus dentata*, J. Havelka, NAAS; 5 alate viviparous females, Mt. Yonggaksan, Pyeongyang-si, North Korea, 14.v.1988, Coll 88HA2418, on *Quercus dentata*, J. Havelka, NAAS; 1 alate viviparous female, Mt. Yonggaksan, Pyeongyang-si, North Korea, 14.v.1988, Coll 88HA2439, J. Havelka, NAAS.

Host plant. Quercus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. Often ant-attended. According to Qiao and Quednau, sexual morph is occur on *Q. dentata*.

Distribution. Korea, China, Japan and Eastern Siberia.

Remarks. This species is relatively rare in Kroea.

Subgenus *Arakawana* Matsumura, 1917 검은낙타진딧물아속 (신칭)

Type species: *Tuberculatus stigmata* Matsumura, 1917: 354, 375.

= *Tuberculatus* (*Arakawana*) *stigmatus* (Matsumurs, 1917).

Diagnosis. This subgenus is recognized from other subgenera by having no spinal tubercles on thorax and entirely black pigmented head, thorax and hind leg, Pts of fore wing black bordered.

Host plant. *Quercus* spp.* (Fagaceae).

Distribution. Palearctic region.

Remarks. This subgenus comprises 2 species distributed in East-Asia (Korea, China, Japan and Eastern Siberia). All species are associated with *Quercus* spp. (Fagaceae).

Key to the species of *Arakawana* Matsumura in Korea

1. Abdominal tergite VIII with 10-12 spinal setae, Spinal tubercle on abdominal dorsum I-II well developed, abdominal margin V with marginal tubercle............ ....***T*. (*A*.) *stigmatus***

2. Abdominal tergite VIII with 6-7 spinal setae, Spinal tubercle on abdominal dorsum I-II poorly developed, abdominal margin V absent of marginal tubercle. ....***T*. (*A*.) *orientalis***

***Tuberculatus* (*Arakawana*) *orientalis* Richards, 1968 stat. rev.**

동양검은낙타진딧물 (신칭)

Tuberculatus (*Tuberculatus*) *orientalis* Richards, 1968: 564, 576.

Tuberculatus (*Acanthocallis*) *stigmatus* Hille Ris Lambers, 1974: 52.

Tuberculatus (*Arakawana*) *stigmatus* Remaudière & Remaudière 1997: 228.

Diagnosis. This species is recognized from the only other congeneric species, *T*. (*A*.) *stigmatus* Matsumura, by having 6-7 spinal setae on abdominal dorsum VIII, absent of tubercles on abdominal margin V and poorly developed tubercles on dorsal abdomen I-II.

Description. Alate viviparous female. Color in iife. Body blackish gray to black with shine, abdominal dorsal tubercles black; head and thorax shiny black, compound eye red; Ant.I-II black, Ant.III-IVb pale with dark distal joint; fore and middle legs pale, hind legs black; Rs of fore wing dark bordered; Cauda and SIPH black. *Morphology* (Table S24; Fig. S24). Body oval, 1.77-2.38mm long; Head slightly wrinkled with 0.07-0.20mm long and fine seate on small elevations, epicranial suture not developed, antennal tubercle developed; Antenna 6-segmented, 0.77-0.98 times as long as body length, inner margin of Ant.I bulging, Ant.I-III slightly imblicated, Ant.IV-VI imblicated, Ant.III with 5-8 rounded secondary rhinaria in a row on basal half, longest setae on Ant.III 1.67-3.00 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT 1.84-2.54 times as long as Ant.VIb, Ant.VIb with only 1 invisible seta; Rostrum not reaching to middle coxae, URS 0.10-0.12mm long with 8-11 accessory setae, 0.71-1.20 times as long as 2HT; Longest setae on HTB 2.17-3.00 times as long as middle width of HTB, hind first tarsal chaetotaxy 6; Thorax without tubercles; Abdominal dorsum I-III with a pair of tubercles, spicules distinctly developed, tubercles on abdominal dorsum I-II poorly developed, tubercles on abdominal dorsum III broadely fused basally, 0.26-0.44mm long with 2-4 hair like setae, abdominal tergite VIII with 4-6 setae, abdominal margin I-IV pigmented with small tubercles, wax gland pore developed, 4th marginal tubercle with 4-5 setae; SIPH dark pigmented including its surrounginds, 0.09-0.14mm long with distal flange; Cauda knobbed, 0.12-0.16mm with 11-16 long and fine setae; Anal plate bilobed, each lobe with 13-16 setae.

Materials examined. 1 alate viviparous female, Seoul, South Korea, 21.v.1968, Coll 4599, on *Quercus donarium*, W.H. Paik, NAAS; 1 alate viviparous female, Suwon-si, GG, South Korea, 19.xi.1968, Coll 4854, on *Quercus* sp., W.H. Paik, NAAS; 1 alate viviparous female, Jeonju-si, JB, South

Korea, 1-10.ix.1969, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Suwon-si, GG, South Korea, 10.viii.1970, Coll 6060, on *Quercus* sp., W.H. Paik, NAAS; 3 alate viviparous females, Taeseongsan Pyeongyang-si, North Korea, 22.vi.1985, Coll 85HA1930, on *Quercus dentata*, J. Havelka, NAAS; 3 alate viviparous females, Taeseongsan Pyeongyang-si, North Korea, 30.vi.1985, Coll 85HA1029, on *Quercus dentata*, J. Havelka, NAAS; 13 alate viviparous females, Taeseongsan Pyeongyang-si, North Korea, 30.vi.1985, Coll 85HA1043, on *Quercus dentata*, J. Havelka, NAAS; 1 alate viviparous female, Taeseongsan Pyeongyang-si, North Korea, 30.vi.1985, Coll 85HA1045, on *Quercus dentata*, J. Havelka, NAAS; 3 alate viviparous females, Mt. Geumgangsan, North Korea, 5.vi.1987, Coll 85HA167587, on *Quercus mongolica*, J. Havelka, NAAS; 51 alate viviparous female, 25-sadan, Beakhak-myeon, GG, South Korea, 21.vii.2008, Coll 080721-HJ16, on *Quercus* sp., H. Kim, CALS SNU; 5 alate viviparous females, Mt. Manwolsan, Yangyang-gun, GW, South Korea, 14.viii.2013, 130814YR-5, on *Quercus* sp., Y. Lee, CALS SNU.

Host plant. Quercus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves. Often ant-attended.

Distribution. Korea and China.

Remarks. This species is new to Korea. *T.* (*A.*) *orientalis* was synonymized into *T.* (*A.*) *stigmatus* (Matsumura) by Hille Ris Lambers (1974). I revived this species based on distinct morphological features combined with DNA barcoding results.

***Tuberculatus* (*Arakawana*) *stigmatus* (Matsumura, 1917) 검은낙타진딧물**

Arakawana stigmata Matsumura, 1917: 354, 375.

Myzocallis nigra Okamoto and Takahashi, 1927: 143.

Tuberculoides stigmata Tao, 1964: 216.

Tuberculatus (*Tuberculatus*) *stigmatus* Richards, 1968: 589; 1969: 52.

Tuberculatus stigmatus Higuchi, 1969: 119; 1972: 49; Pashtshenko, 1981: 43.

Tuberculatus (*Acanthocallis*) *stigmata* Eastop and Hille Ris Lambers, 1976: 93; Quednau, 1979: 505; Quednau and Shaposhnikov, 1988: 1026.

Tuberculatus (*Arakawana*) *stigmatus* Sorin, 1992: 7; Remaudière and Remaudière, 1997: 228; Quednau, 1999: 34.

Diagnosis. This species is distinguished from *T*. (*A*.) *orientalis* Richards by having 10-12 spinal setae on abdominal dorsum VIII, abdominal margin V with marginal tubercle and well developed tubercles on dorsal abdomen I-II.

Description. Alate viviparous female. Color in iife. Body dirty yellow to yellowish gray with shine, abdominal dorsal tubercles and marginal tubercles black, head and thorax shiny black, compound eye red, Ant.I-II black, Ant.III-IVb pale with dark distal joint, distal half of PT dark; fore and middle legs pale, basal 1/4 of middle tibiae dark, hind legs black; Rs of fore wing dark bordered; Cauda pale; SIPH black. *Morphology* (Table S25; Fig. S25). Body oval, 1.28-2.93mm long; Head slightly wrinkled with 0.05-0.19mm long and fine seate on small elevations, epicranial suture slightly developed, antennal tubercle developed; Antenna 6-segmented, 0.71-1.36 times as long as body length, inner margin of Ant.I bulging, Ant.I-III slightly imblicated, Ant.IV-VI imblicated, Ant.III with 4-13 rounded secondary rhinaria in a row on basal 3/4, longest setae on Ant.III 1.25-3.00 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT 1.62-2.21 times as long as Ant.VIb, Ant.VIb with only 1 invisible seta; Rostrum not reaching to middle coxae, URS 0.11-0.12mm long with 8-9 accessory setae, 0.73-1.20 times as long as 2HT; Longest setae on HTB 1.86-2.50 times as long as middle width of HTB, hind first tarsal chaetotaxy 6; Thorax without tubercles; Abdominal dorsum I-III with a pair of tubercles broadely fused basally, tubercles on abdominal dorsum III, 0.29-0.44mm long with 3-4 hair like setae, some specimens rarely have a pair of tubercles on abdominal dorsum IV-V, spicules distinctly developed on dorsal tubercles, abdominal tergite VIII with 8-12 setae, abdominal margin I-V pigmented with well developed tubercles, wax gland pore developed, 4th marginal tubercle with 4-6 setae; SIPH dark pigmented including its surroungings, 0.06-0.17mm long with distal flange; Cauda knobbed, 0.14-0.18mm with 14-17 long and fine setae; Anal plate bilobed, each lobe with 13-15 setae.

Materials examined. 1 alate viviparous female, Suwon-si, GG, South Korea, 19.v.1968, Coll 4555, on *Quercus* sp., W.H. Paik, NAAS; 2 alate viviparous females, Suwon, GG, South Korea, 14.vi.1969, Coll 4964, on *Quercus* sp., W.H. Paik, NAAS; 4 alate viviparous females, Daeheung temple, JN, 3.vi.1971, Coll 6588, on *Quercus acutissima*; 5 alate viviparous females, Samilpo, Mt. Geumgangsan, North Korea, 20.v.1988, Coll 88HA2449, on *Quercus aliena*, J.

Havelka, NAAS; 1 alate viviparous female, Mt. Yonggaksan, Pyeongyang-si, North Korea, 6.vi.1985, Coll 85HA0372, on *Quercus dentata*, J. Havelka, NAAS; 1 alate viviparous female, Taeseongyo, North Korea, 5.v.1985, Coll 85HA0859, on *Quercus dentata*, J. Havelka, NAAS; 2 alate viviparous female, Gwangreung-national arboretum, Pocheon-si, GG, South Korea, 21.v.1999, Coll 990521SH-35, on *Cornus controversa*, S. Lee, CALS SNU; 2 alate viviparous female, Hangyearyeong, Yangyang-gun, GW, South Korea, 4.vi.1999, Coll 990602SH-63, on *Quercus magnolica*, S. Lee, NAAS; 2 alate viviparous female, Danseong-myeon, Danyang-gun, CB, 18.v.2001, Coll 011517-SH19, on *Quercus* sp., S. Lee, NAAS; 1 alate viviparous female, Chiak-recration forest, Wonju-si, GW, South Korea, 20.viii.2013, Coll 130820YR-11, on *Quercus* sp., Y. Lee, CALS SNU; 2 alate viviparous females, Seoul National Univ., Gwanak-gu, Seoul, South Korea, 26.iv.2014, Coll 140426YR-9, on *Quercus* sp., Y. Lee, CALS SNU; 3 alate viviparous females, Mt. Jugeumsan, Gapyeong-gun, GG, South Korea, 9.v.2014, Coll 140509YR-3, on *Quercus* sp., Y. Lee, CALS SNU; 3 alate viviparous females, Mt. Chilgapsan, Cheongyang-gun, CN, South Korea, 10.v.2014, Coll 140509YR-3, on *Quercus* sp., Y. Lee, CALS SNU; 7 alate viviparous females, Sinwon-ri, Yongin-si, GG, South Korea, 16.v.2014, Coll 140516YR-2, on *Quercus* sp., Y. Lee, CALS SNU.

Host plant. Quercus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves. Often ant-attended.

Distribution. Korea, China, Japan and Eastern Siberia.

Remarks. This species is only distributed in East Asia.

Subgenus *Nippocallis* Matsumura, 1917 밤나무낙타진딧물아속 (신칭)

Type species: *Nippocallis kuricola* Matsumura, 1917: 353, 365.

Diagnosis. This subgenus is closely related to the subgenus *Nippotuberculatus* (Quednau) but can be recognized by having absent of Rs on fore wing, no conspicuous tubercles on abdominal dorsum and finger like marginal tubercle on abdominal tergite IV.

Host plant. *Castanea* spp.* (Fagaceae).

Distribution. Oriental and Palearctic region, introduced into Neotropical region.

Remarks. This subgenus comprises 5 species originally distributed in Asia (Korea, China, Japan and Taiwan). Recently, *T.* (*N.*) *kuricola* has been introduced into Europe and South America. All species are associated with *Castanea* spp. (Fagaceae). Systematic position of this subgenus undergone a lot of changes and is still controversial.

Key to the species of *Nippocallis* Matsumura in Korea

1. Abdominal dorsal tergite with a pair of pigmented elevations, each elevation with two setae .... ***T.* (*N.*) *kuricola***
2. Abdominal dorsal tergite with a pair of pigmented elevations, each elevation with 3-5 spinal setae .... ***T.* (*N.*) *hirta* sp. nov.**

***Tuberculatus* (*Nippocallis*) *hirta* Lee, sp. nov. 숨은밤나무낙타진딧물 (신칭)**

Diagnosis. This species can be recognized from closely related species *T*. (*N*.) *kuricola* Matsumura by having more hairs on central dorsal abdominal elevations.

Description. Alate viviparous female. Color in iife. Body dark yellowish green to dirty yellow covered with whitish wax powder, abdominal dorsal elevations and marginal tubercles dark; Head and thorax concolorous with body, compound eye red; Antennae pale, distal joint of Ant.III-IVb slightly dark; legs pale; Wing veins of fore wing dark bordered; Cauda pale; SIPH dark. *Morphology* (Table S26; Fig. S26). Body oval, 1.79-2.19mm long; Head slightly wrinkled with 0.07-0.12mm long and fine seate on small elevations, epicranial suture absent, antennal tubercle poorly developed; Antenna 6-segmented, much shorter than body length, 0.57-0.67 times as long as body length, inner margin of Ant.I bulging, Ant.I-III slightly imblicated, Ant.IV-VI imblicated, Ant.III with 6-8 rounded secondary rhinaria in a row on basal 2/3, longest setae on Ant.III 2.33-2.67 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT 0.73-1.00 times as long as Ant.VIb, Ant.VIb with only 1, 0.02mm of seta; Rostrum not reaching to middle coxae, URS 0.11-0.13mm long with 10-11 accessory setae, 1.00-1.09 times as long as 2HT; Longest setae on HTB 1.50-2.67 times as long as middle width of HTB, hind first tarsal chaetotaxy 7; Rs on fore wing absent; Thorax without tubercles; Each abdominal dorsal tergite with 2-5 long and fine setae on a pair of pigmented elevations, 1-10 setae on small pigmented elevation scattered arround the central elevations, abdominal tergite VIII with 5-10 setae; abdominal margin I-V pigmented with well developed tubercles, 4th marginal tubercle conspicuously developed with 6-9 setae; SIPH pigmented including its surrounding, 0.09-0.10mm long with distal flange; Cauda knobbed, 0.08-0.11mm with 10-13 long and fine setae; Anal plate bilobed, each lobe with 10-15 setae.

Types. Holotype. 1 alate viviparous female, Sinwon-ri, Yongin-si, GG, South Korea, 16.v.2014, Coll 140516-YR4, on *Castanea* sp., Y. Lee, CALS SNU; Paratypes. 2 alate viviparous female, same data as the holotype; 2 alate viviparous females, Sinwon-ri, Yongin-si, GG, South Korea, 23.v.2015, Coll 150523-YR1, on *Castanea* sp., Y. Lee & H. Lee, CALS SNU; 5 alate viviparous females, Yangu-gun, GW, South Korea, 31.v.2015, Coll 150531-YR10, on *Castanea* sp., Y. Lee & H. Lee, CALS SNU; 1 alate viviparous female, Mulhyanggi-arboretum, Osan-si, GG, South Korea, 1.vi.2015, Coll 150601YR-23, on *Castanea* sp., Y. Lee, CALS SNU.

Host plant. Castanea spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On upperside of leaves. Often ant-attended.

Distribution. Korea and Japan.

Remarks. This species is newly recognized from Korea.

Etymology. The species name *hirta* is derived from Latin adjective hirtus (hairy), referring to hairy body.

***Tuberculatus* (*Nippocallis*) *kuricola* Matsumura, 1917 밤나무낙타진딧물**

Nippocallis kuricola Matsumura, 1917: 353, 365.

Myzocallis kuricola Essig and Kuwana, 1918: 92.

Myzocallis (*Agrioaphis*) *kuricola* Richards, 1968: 37.

Myzocallis (*Nippocallis*) *kuricola* Eastop and Hille Ris Lambers, 1976: 293; Quednau, 1979: 504.

Tuberculatus (*Nippocallis*) *kuricola* Remaudière and Remaudière, 1997: 228; Quednau, 1999: 36; Qiao and Zhang, 2002: 84.

Diagnosis. This species is morphologically very similar to congeneric species *T.* (*N.*) *hirta* **sp. nov.** However, it differs in having less hairs on dorsal abdominal tergites.

Description. Alate viviparous female. Color in iife. Body dark yellowish green to dirty yellow covered with whitish wax powder, abdominal dorsal elevations and marginal tubercles dark; head and thorax concolorous with body, compound eye red; Antenna pale, distal joint of Ant.III-IVb slightly dark; legs pale; Wing veins of fore wing dark bordered; Cauda pale; SIPH dark. *Morphology* (Table S27; Fig. S27). Body oval, 1.40-2.08mm long, Head slightly wrinkled with 0.09-0.13mm long and fine seate on small elevations, epicranial suture absent, antennal tubercle poorly developed; Antenna 6-segmented, much shorter than body length, 0.56-0.66 times as long as body length, inner margin of Ant.I bulging, Ant.I-III slightly imblicated, Ant.IV-VI imblicated, antennal setae on Ant.I-IV long and pointed, Ant.III with 5-9 rounded secondary rhinaria in a row on basal 2/3, longest setae on Ant.III 3.00-4.50 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT 0.64-1.11 times as long as Ant.VIb, Ant.VIb with 0.01mm of 1 inconspicuous seta; Rostrum not reaching to middle coxae, URS slender, 0.10-0.13mm long with 9-11 accessory setae, 1.11-1.18 times as long as 2HT; Longest setae on HTB 1.75-2.67 times as long as middle width of HTB, hind first tarsal chaetotaxy 8; Rs of fore wing absent; Thorax without tubercles; Each abdominal dorsal tergite with two pairs of long and fine setae on a pair of pigmented elevations, 1-6 setae on small pigmented elevation scattered arround the central elevations, abdominal tergite VIII with 6-8 setae, abdominal margin pigmented, abdominal tergite I-V with 3-6 long and pointed setae on well developed tubercles, 4th marginal tubercle conspicuously developed with 6-7 setae; SIPH pigmented including its surroundings, 0.08-0.10mm long with distal flange; Cauda knobbed, 0.08-0.12mm with 11-14 long and fine setae; Anal plate bilobed, each lobe with 9-15 setae.

Materials examined. 1 alate viviparous female, Chusan experimental forest, Gwanyang-si, JN, South Korea, 25.vii.2013, Coll 130725-10, on *Castanea* sp., Y. Lee, CALS SNU; 1 alate viviparous female, Mt. Ungilsan, Namyangju-si, GG, South Korea, 17.ix.2013, Coll 130917HS-03, on *Castanea* sp., H. Lee, CALS SNU; 1 alate viviparous female, Mt. Chilgapsan, Cheongyang-gun, CN, South Korea, 10.v.2014, Coll 140510YR-2, on *Castanea crenata*, Y. Lee & H. Lee, CALS SNU; 3 alate viviparous females, Sinwon-ri, Yongin-si, GG, South Korea, 16.v.2014, Coll 140516YR-4, on *Castanea* sp., Y. Lee & H. Lee, CALS SNU; 5 alate viviparous females, Anseong-si, GG, South Korea, 23.v.2015, Coll 150523YR-1, on *Castanea* sp., Y. Lee & H. Lee, CALS SNU; 1 alate viviparous female, Mulhyanggi-arboretum, Osan-si, GG, South Korea, 1.vi.2015, Coll

150601YR-23, on *Castanea* sp., Y. Lee, CALS SNU; 8 alate viviparous females, Yangpyeong-gun, GG, South Korea, 12.vi.2015, Coll 150612YR -12, on *Castanea* sp., Y. Lee, CALS SNU.

Host plant. Castanea spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On upperside of leaves. Often ant-attended.

Distribution. Korea, China, Japan, Taiwan, Eastern Siberia, Spain, Maderia and Brazil.

Remarks. This species is one of the common species in Korea. Originally, this species is widely distributed in Asian region and recently introduced into Europe and South America.

Subgenus *Orientuberculoides* Hille Ris Lambers, 1974 동양낙타진딧물아속 (신칭)

Type species: *Myzocallis yokoyamai* Takahashi, 1923: 63, 120.

= *Tuberculatus* (*Orientuberculoides*) *yokoyamai* (Takahashi, 1923).

Diagnosis. This subgenus is easily recognized from other subgenera by having pale body, rarely sclerotized, mesonotum never with spinal tubercles, Pts of fore wing clear without dark markings.

Host plant. Quercus spp.* (Fagaceae).

Distribution. Oriental and Palearctic regions.

Remarks. This subgenus comprises 12 species originally distributed in Asia (Korea, Buthan, China, India, Japan, Taiwan and Eastern Siberia). All species are associated with *Quercus* spp. (Fagaceae).

Key to the species of *Orientuberculoides* Hille Ris Lambers in Korea

1. Pronotum with two pairs of spinal tubercles **2**

- Pronotum without/with only a pair of spinal tubercle **3**

2. Setae on body parts capitated .... ***T.* (*O.*) *capitatus***

- Setae on body parts pointed .... ***T.* (*O.*) *fangi***

3. Pronotum without finger like spinal tubercle **4**

- Pronotum with a pair of finger like spinal tubercle... **5**

4. Setae on Ant.I 0.03mm long, Ant.III with 6-9 secondary rhinaria, tibiae dark . ... ***T.* (*O.*) *paranaracola***

- Setae on Ant.I 0.02mm long, Ant.III with 4-8 secondary rhinaria, tibiae pale ... . ***T.* (*O.*) *richardsi* sp. nov.**

5. Rostrum reaching to middle coxae, URS 0.16-0.18mm long............................ .... ***T.* (*O.*) *querciformosanus***

- Rostrum not reaching to middle coxae, URS 0.08-0.14mm long **6**

6. Antenna 2.71-2.90mm long .... ***T.* (*O.*) *alba* sp. nov.**

- Antenna 1.92-2.53mm long.. **7**

7. Longest setae on Ant.I-II 0.03-0.06mm, URS 0.12-0.14mm long **8**

- Longest setae on Ant.I-II 0.01-0.03mm, URS 0.09-0.12mm long **9**

8. Longest setae on Ant.III 0.01-0.01mm, URS 1.27 times as long as 2HT ....
....***T.* (*O.*) *paiki***

- Longest setae on Ant.III 0.03-0.04mm, URS 0.90-1.08 times as long as 2HT...
.... ***T.* (*O.*) *yaoi* sp. nov.**

9. Longest setae on Ant.III 0.67-1.00 times as long as BDAnt.III ....
....***T.* (*O.*) *silvae* sp. nov.**

- Longest setae on Ant.III 0.33-0.67 times as long as BDAnt.III...................... **10**

10. Spinal tubercles on pronotum 0.07-0.08mm long .... ***T.* (*O.*) *yokoyamai***

- Spinal tubercles on pronotum 0.03-0.04mm long... **11**

11. Ant.III 0.41-0.60mm long with 9-10 setae .... ***T.* (*O.*) *higuchii***

- Ant.III 0.75-0.85mm long with 12-14 setae................***T.* (*O.*) *lambersi* sp. nov.**

***Tuberculatus* (*Orientuberculoides*) *alba* Lee, sp. nov. 흰동양낙타진딧물 (신칭)**

Diagnosis. Alate viviparoud females. This species is morphologically very similar to *T*. (*O*.) *yokoyamai* (Takahashi). However, it can be distinguished by having longer length of Ant.V, SIPH and Cauda.

Description. Alate viviparous female. Color in iife. Body pale to pale yellow, abdominal dorsal tubercles pale, marginal tubercles pale, thorax concolorous with body; Head pale yellow, compound eye pale; Antennae pale, distal joint of Ant.III-IVb dark abnded; legs pale, tip of tarsus dark; Wing veins of fore wing not conspicuous; Cauda and SIPH pale. *Morphology* (Table S28;

Fig. S28). Body oval, 2.52-2.74mm long; Head slightly wrinkled with 0.10-0.13mm long and capitated seate on small elevations, epicranial suture poorly developed, antennal tubercle developed; Antenna 6-segmented, almost same or slightly longer than body length, 1.01-1.15 times as long as body length, inner margin of Ant.I bulging, Ant.I-III slightly imblicated, Ant.IV-VI imblicated, Ant.III with 5-8 rounded secondary rhinaria in a row on basal 2/3, longest setae on Ant.III 0.50-1.10 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT 1.22-1.36 times as long as Ant.VIb, Ant.VIb with 1 short and inconspicuous setae; Rostrum not reaching to middle coxae, URS slender, 0.12-0.13mm long with about 8-9 accessory setae, 0.93-1.00 times as long as 2HT; Tibial setae 1.00-1.67 times as long as middle width of HTB, hind first tarsal chaetotaxy 8; Pro- and metanotum without tubercles, mesonotum with a pair of spinal tubercle; Abdominal dorsal tergite I-IV with a pair of 0.09-0.21mm finger like tubercles with 3-5 setae, tubercles on abdominal tergite IV poorly developed, abdominal tergite VIII with 7-9 blunted setae, abdominal margin I-V with 4-6 blunted setae on well developed marginal tubercles, marginal tubercle spiculose; SIPH cylindrical, 0.13-0.14mm long, tip of SIPH slightly pigmented with distal flange; Cauda knobbed, 0.16-0.17mm with 13-15 setae; Anal plate bilobed, each lobe with 13-16 setae.

Types. Holotype. 1 alate viviparous female, Mt. Gwanggyosan, Suwon-si, GG, South Korea, 10.v.2015, Coll 150510YR-2, on *Quercus* sp., Y. Lee & H. Lee, CALS SNU; Paratypes. 7 alate viviparous females, same data as the holotype; 1 alate viviparous female, Mt. Taehwasan, Gwangju-si, GG, South Korea, 16.vi.2012, Coll 120616HR-2, on *Quercus* sp., H. Choi, CALS SNU; 1

alate viviparous female, Mt. Jogyesan, Suncheon-si, JN, South Korea, 4.v.2015, Coll 150504YR-15, on *Quercus* sp., Y. Lee & H. Lee, CALS SNU.

Host plant. Quercus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea and Japan.

Etymology. The species name *alba* is derived from Latin adjective alba (pale), referring to pale body color.

Remarks. This species is newly recognized from Korea. Yao (2010) recognized this species as *T*. (*O*.) sp. D based on DNA barcoding. But he didn't describe this species.

***Tuberculatus* (*Orientuberculoides*) *capitatus* (Essig & Kuwana, 1918) 못털낙타진딧물**

Myzocallis capitata Essig and Kuwana, 1918: 89; Takahashi, 1923: 123.

Tuberculoides capitata Shinji and Kondo, 1938: 56; Tseng and Tao, 1938: 209.

Tuberculatus (*Tuberculatus*) *capitatus* Richards, 1968: 566; 1969: 53.

Tuberculatus capitatus Higuchi, 1969: 112; 1972: 47.

Tuberculatus (*Orientuberculoides*) *capitatus* Hille Ris Lambers, 1974: 42; Remaudière and Remaudière, 1997: 228; Quednau, 1999: 40; Quednau, 2003: 295.

Diagnosis. This species is morphologically very similar to *T*. (*O*.) *fangi* but can be distinguished by having capitated hairs on body parts and having 1-2 almost invisible setae on Ant. VIb.

Description. Alate viviparous female. Color in iife. Body pale yellow, greenish yellow to bright yellow, abdominal dorsal tubercles and marginal tubercles pale; Head and thorax concolorous with body, compound eye pale; Antenna pale, distal joint of Ant.III-IVb dark banded; Legs pale; Wing veins of fore wing inconspicuous; Cauda and SIPH pale. *Morphology* (Table S29; Fig. S29). Body oval, 1.67-2.87mm long; Head slightly wrinkled with 0.10-0.13mm long and capitated seate on small elevations, epicranial suture absent, antennal tubercle developed; Antenna 6-segmented, 0.67-1.07 times as long as body length, inner margin of Ant.I bulging, Ant.I-II faintly imblicated, Ant.III-VI imblicated, antennal setae on Ant.I-III capitated, Ant.III with 3-4 rounded secondary rhinaria in a row on basal 1/3, longest setae on Ant.III 1.33-2.00 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT 1.14-1.79 times as long as Ant.VIb, Ant.VIb with 0.01mm of 1-2 inconspicuous seta; Rostrum not reaching to middle coxae, URS 0.11-0.14mm long with 7-9 accessory setae, 0.92-1.00 times as long as 2HT; Longest setae on HTB 1.00-1.80 times as long as middle width of HTB, hind first tarsal chaetotaxy 8; Prono- and metanotum without tubercles, mesonotum with two pairs of tubercles; Abdominal dorsal tergite I-III with a pair of finger-like tubercles, longest tubercles on abdominal dorsum III 0.16-0.19mm long with 2-4 capitated setae, abdominal tergite VIII with 3-5 setae, abdominal margin I-V with 2-4 setae on tubercles, 4th marginal tubercle well developed; SIPH cylindrical, 0.13-

0.15mm long, tip of SIPH slightly pigmented with distal flange; Cauda knobbed with spicules, 0.12-0.20mm long with 15-22 setae; Anal plate bilobed, each lobe with 13-21 setae.

Materials examined. 1 alate viviparous female, Suwon-si, GG, South Korea, 15.v.1968, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 6 alate viviparous females, Cheongju-si, CB, South Korea, 12.viii.1969, Coll 5274, on *Quercus acutissima*, W.H. Paik, NAAS; 6 alate viviparous females, Suwon-si, GG, South Korea, 10.viii.1970, Coll 6062, on *Quercus acutissima*, W.H. Paik, NAAS; 2 alate viviparous females, Sagok-myeon, Uiseong-gun, GB, South Korea, 25.v.2000, Coll 000522GS-63.1, on *Quercus* sp., G.S. Lee, NAAS; 7 alate viviparous females, Ewha womans University, Daehyeon-dong, Seodaemun-gu, Seoul, South Korea, 12.v.2013, Coll 130512YR-9, on *Quercus acutissima*, Y. Lee & H. Lee, CALS SNU; 1 alate viviparous female, Seoul National Univ., Gwanak-gu, Seoul, South Korea, 21.vii.2013, Coll 130721YR-2, on *Quercus acutissima*, Y. Lee & H. Lee, CALS SNU; 4 alate viviparous females, Is. Geojedo, GN, South Korea, 14.vii.2014, Coll 140714YR-4, on *Quercus acutissima*, Y. Lee & H. Lee, CALS SNU; 4 alate viviparous females, Seoul National Univ., Gwanak-gu, Seoul, South Korea, 14.v.2015, Coll 150514TC-1, on *Quercus acutissima*, Y. Lee & H. Lee, CALS SNU; 7 alate viviparous females, Mt. Barasan, Suwon-si, GG, South Korea, 7.vi.2015, Coll 150607YR-7, on *Quercus acutissima*, Y. Lee & H. Lee, CALS SNU.

*Host plant. Quercus acutissima** (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves. Often ant-attended.

Distribution. Korea, China, Japan and Taiwan.

Remarks. This species is only collected on *Q. acutissima* in Korea.

Tuberculatus (_Orientuberculoides_) _fangi_ (Tseng & Tao, 1938) 뾰족털낙타진딧물

Tuberculatus fangi Tseng and Tao, 1938: 209; Tao, 1964: 215.

Tuberculatus (*Tuberculatus*) *tuberculatus* Richards, 1968: 564, 591.

Tuberculatus (*Orientuberculoides*) *fangi* Hille Ris Lambers, 1972: 23, 45; Remaudière and Remaudière, 1997: 228; Quednau, 1999: 40.

Diagnosis. This species is morphologically very similar to *T*. (*O*.) *capitatus* but can be distinguished by having pointed hairs on body parts and having 0.02-0.05mm of 2 setae on Ant. VIb.

Description. Alate viviparous female. Color in iife. Body pale green to greenish yellow, abdominal dorsal tubercles and marginal tubercles pale; Head and thorax concolorous with body, compound eye pale; Antenna pale, distal joint of Ant.III-IVb dark banded; Legs pale; Wing veins of fore wing inconspicuous or slightly fuscous; Cauda and SIPH pale. *Morphology* (Table S30; Fig. S30). Body oval, 1.87-2.87mm long; Head slightly wrinkled with 0.10-0.15mm long and pointed seate on small elevations, epicranial suture absent, antennal tubercle developed; Antenna 6-segmented, 0.59-0.98 times as long as body length, inner margin of Ant.I bulging, Ant.I-II faintly imblicated, Ant.III-VI imblicated, antennal setae pointed shape or slightly blunted, Ant.III with 2-4 rounded secondary rhinaria in a row on basal 1/4, longest setae on Ant.III 1.67-3.33 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT 1.06-1.71 times as long as Ant.VIb, Ant.VIb with 0.02-0.05mm of 2 hair like setae; Rostrum not reaching to middle coxae, URS 0.12-0.13mm long with 10-15 accessory setae, 0.92-1.08 times as long as 2HT; Longest setae on HTB 1.50-2.75 times as long as middle width of HTB, hind first tarsal chaetotaxy 8; Prono- and metanotum without tubercles, mesonotum with two pairs of tubercles; Abdominal dorsal tergite I-III with a pair of finger-like slightly pigmented tubercles with spicules, longest tubercle on 0.09-0.16mm long with 2 pointed setae, abdominal tergite VIII with 5-6 spinal setae, abdominal margin I-IV with 3-4 pointed setae on tubercles, wax gland pores and spicules developed, 4th marginal tubercles well developed; SIPH cylindrical, 0.12-0.15mm long, tip of SIPH slightly pigmented with distal flange; Cauda knobbed, 0.15-0.19mm with 16-19 long and fine setae; Anal plate bilobed, each lobe with 15-19 setae each.

Materials examined. 1 alate viviparous female, Mt. Jirisan, Gwangyang-si, JN, South Korea, 9.viii.1963, Coll 2382, on *Quercus acutissima*, W.H. Paik, NAAS; 1 alate viviparous female, Wonju-si, GW, South Korea, 22.ix.1963, Coll 2717, on *Q. acutissima*, W.H. Paik, NAAS; 1 alate viviparous female, Uljin-gun, GB, South Korea, 5.x.1963, Coll 2774, on *Q. acutissima*, W.H. Paik, NAAS; 6 alate viviparous females, Ehwa Woman's Univ., Seodaemun-gu, Seoul, South Korea, 12.v.2013, Coll 130512-9, on *Quercus* sp., Y. Lee & H. Lee, CALS SNU; 14 alate viviparous females, Seoul National Univ., Gwanak-gu, Seoul, South Korea, 19.vii.2013, Coll 130719YR-1, on *Q. acutissima*, Y. Lee & H. Lee, CALS SNU; 8 alate viviparous females, Seoul National Univ., Gwanak-gu, Seoul, South Korea, 16.iX.2013, Coll 130916YR-1, on *Q. acutissima*, Y. Lee & H. Lee, CALS SNU; 16 alate viviparous females, Seoul National Univ., Gwanak-gu, Seoul, South Korea, 16.iX.2013, Coll 130916YR-2, on *Q. acutissima*, Y. Lee & H. Lee, CALS SNU; 8 alate viviparous females, Seoul National Univ., Gwanak-gu, Seoul, South Korea, 28.X.2013, Coll 131028YR-1, on *Q. acutissima*, Y. Lee & H. Lee, CALS SNU.

Host plant. Quercus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves. Often ant-attended.

Distribution. Korea, China and Japan.

***Tuberculatus* (*Orientuberculoides*) *fuscotuberculatus* Zhang, Zhang & Zhong, 1990 검은혹동양낙타진딧물 (신칭)**

Tuberculatus fuscotuberculatus Zhang, Zhang and Zhong, 1990: 101, 104, 115.
Tuberculatus konaracola gansuensis Zhang, Zhang and Zhong, 1990: 101, 107, 116.
Tuberculatus (*Orientuberculoides*) *konaracola fuscotuberculatus* Quednau, 1997: 229; Remaudière and Remaudière, 1997: 228, 229.
Tuberculatus (*Orientuberculoides*) *fuscotuberculatus* Quednau, 1999: 38; 2003: 291, 295.

Diagnosis. This species can be distinguished from closely related species *T*. (*O*.) *konaracola* (Shinji) by having 4-5 blunted or pointed setae on Ant.III, abdominal marginal setae with 3-4 setae.

Description. Oviparous female. Color in iife. Not available. *Morphology* (Table S31; Fig. S31). Body oval spindle shape, 3.02-3.38mm long; Head slightly wrinkled with 0.09-0.12mm long and capitated setae on small elevations, epicranial suture poorly developed, antennal tubercle developed; Antenna 6-segmented, inner margin of Ant.I bulging, antennal setae on capitated or pointed, Ant.III without secondary rhinaria longest setae on Ant.III 0.75 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, Ant.VIb with 0.01mm of single seta; Rostrum not reaching to middle coxae, URS 0.11mm long with 4 accessory setae, 0.61-0.79 times as long as 2HT; Longest setae on HTB 0.07 times as long as middle width of HTB, hind first tarsal chaetotaxy 7, tibiae swollen with 160-171 peudosensoria; Torax and abdominal dorsal tergite I-V with dark sclerotized band, abdominal tergite VIII with 4-5 setae, abdominal margin I-V with 2-4 capitated setae on sclerotized elevations, SIPH cylindrical, 0.10-0.13mm long, dark sclerotized with spicules, distal flange developed.

Materials examined. 2 oviparous females, Cheongju-si, South Korea, 1.xi.1963, Coll 3072, on *Sambucus williamsii*, W.H. Paik, NAAS.

Host plant. Quercus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, Japan and China.

Remarks. This species was firstly recorded by Quednau (2000) based on oviparous female. Alate viviparous females haven’t been observed.

Tuberculatus (_Orientuberculoides_) _higuchii_ Hille Ris Lambers, 1974

떡갈나무낙타진딧물

Tuberculatus (*Orientuberculoides*) *higuchii* Hille Ris Lambers, 1974: 23, 32, 46; Quednau, 1979: 506; Quednau and Shaposhnikov, 1988: 1026; Remaudière and Remaudière, 1997: 229; Quednau, 1999: 39.

Diagnosis. This species is morphologically very similar to *T.* (*O.*) *yaoi* **sp. nov.** However, it can be distinguished by having 1-2 setae on fronsal margin, longer length of setae on thorax and shorter length of Ant.II-IV.

Description. Alate viviparous female. Color in iife. Not available. *Morphology* (Table S32; Fig. S32). Body oval, 1.16-2.08mm long; Head slightly wrinkled with 0.08-0.10mm long and blunted setae on small elevations, epicranial suture absent, antennal tubercle developed; Antenna 6-segmented, inner margin of Ant.I bulging, antennal setae on Ant.I-II short and blunted or pointed, antennal setae on Ant.III-VI short almost invisible, Ant.III with 5 rounded secondary rhinaria in a row on basal part, longest setae on Ant.III 0.33-0.50 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, Ant.VIb with 0.01mm of only 1 hair like seta; Rostrum not reaching to middle coxae, URS 0.10mm long with 6-7 accessory setae, 0.83-0.91 times as long as 2HT; Longest setae on HTB 1.25-1.33 times as long as middle width of HTB, hind first tarsal chaetotaxy 7; Pronotum with a pair of tubercles, meso- and metanotum without tubercles; Abdominal dorsal tergite I-III with a pair of finger-like slightly pigmented tubercles bearing 1-2 setae, abdominal tergite VIII with 4 spinal setae, abdominal margin I-IV with elevations, 4th marginal tubercles well developed with 3-4 setae; tip of SIPH pigmented, 0.11-0.12mm long with distal flange; Cauda knobbed, 0.14mm with 13-15 long and fine setae; Anal plate bilobed, each lobe with 12-15 setae.

Materials examined. 2 alate viviparous females, Iwamizawa, Hokkaido, Japan, 29.vi.2008, Coll JP6, on *Quercus crispula*, collector unknown, CALS SNU.

Host plant. Quercus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, Japan and Eastern Siberia.

Remarks. This species was firstly recorded by Quednau (1979) based on North Korean specimens. However, North Korean specimens were not available. I used Japanese specimens in this study. PT was missing in all specimens examined in this study.

***Tuberculatus* (*Orientuberculoides*) *lambersi* Lee, sp. nov.**

닮은떡갈나무낙타진딧물 (신칭)

Diagnosis. This species is morphologically very similar to *T*. (*O*.) *higchii* Hiller is Lambers. However, it can be distinguished by having longer length of Ant.III-IV and Ant.III having 12-14 hairs.

Description. Alate viviparous female. Color in iife. Not available. *Morphology* (Table S33; Fig. S33). Body oval, 2.45-2.76mm long; Head slightly wrinkled with 0.07-0.10mm long and blunted setae on small elevations, epicranial suture slightly developed, antennal tubercle developed; Antenna 6-segmented, inner margin of Ant.I slightly bulging, antennal setae on Ant.I-II short and blunted or pointed, antennal setae on Ant.III-VI short almost invisible, Ant.III with 5-6 rounded secondary rhinaria in a row on basal 1/2, longest setae on Ant.III 0.50 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, Ant.VIb with 0.01mm of only 1 hair like seta; Rostrum not reaching to middle coxae, URS 0.11mm long with 6-7 accessory setae, 0.79-0.85 times as long as 2HT; Longest setae on HTB 0.08-1.25 times as long as middle width of HTB, hind first tarsal chaetotaxy 7; Pronotum with a pair of tubercles, meso- and metanotum without tubercles; Abdominal dorsal tergite I-III with a pair of elevations bearing 1-2 setae, abdominal tergite VIII with 8-10 spinal setae; abdominal margin I-IV with elevations, 4th marginal tubercles well developed with 3-5 setae; tip of SIPH pigmented, 0.12-0.14mm long with distal flange; Cauda knobbed, 0.14-0.16mm with 13-16 long and fine setae; Anal plate bilobed, each lobe with 14-18 setae.

Types. Holotype. 1 alate viviparous female, Seoul National Univ., Gwanak-gu, Seoul,South Korea, 26.iv.2014, Coll 140426YR-2, on *Quercus* sp., Y. Lee & H. Lee, CALS SNU; Paratypes. 6 alate viviparous females, same data as holotype.

Host plant. Quercus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea.

Remarks. This species is newly recognized from Korea.

Tuberculatus (_Orientuberculoides_) _paiki_ Hille Ris Lambers, 1974

백낙타진딧물

Tuberculatus (*Orientuberculoides*) *paiki* Hille Ris Lambers, 1974: 23, 33, 68; Quednau, 1979: 507; Quednau and Shaposhnikov, 1988: 1027; Quednau, 1997: 229; Remaudière and Remaudière, 1997: 229.

Tuberculatus paiki Chakrabarti, Samiran and Raychaudhuri, 1975: 98.

Diagnosis. This species is morphologically similar to *T*. (*O*.) *yokoyamai* but can be distinguished by having 4 secondary rhinaria on Ant.III and longer length of URS.

Description. Alate viviparous female. Color in iife. Not available. *Morphology* (Table S34; Fig. S34). Body oval, 2.06 mm long; Head slightly wrinkled with 0.11-0.12mm long and blunted setae on small elevations, epicranial suture absent, antennal tubercle developed; Antenna 6-segmented, 1.07 times as long as body length, inner margin of Ant.I bulging, Ant.I-III faintly imblicated, Ant.IV-VI imblicated, antennal setae on Ant.I-IV blunted, Ant.III with 4 rounded secondary rhinaria in a row on basal 1/3, longest setae on Ant.III 1.33 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT 1.5 times as long as Ant.VIb, Ant.VIb with 0.01mm of 1 hair like seta; Rostrum not reaching to middle coxae, URS 0.14mm long with 8 accessory setae, 1.27 times as long as 2HT; Longest setae on HTB 1.25 times as long as middle width of HTB, hind first tarsal chaetotaxy 7; Pronotum with a pair of tubercle, meso- and metanotum without tubercles; Abdominal dorsal tergite I-III with a pair of 0.21-0.21mm finger-like tubercles with a pair of setae, abdominal tergite VIII with 7 setae, abdominal margin I-II and V with elevations, abdominal margin III-IV with well developed tubercles bearing 3 setae; tip of SIPH slightly pigmented, 0.11mm long with distal flange; Cauda knobbed, 0.13mm with 15 long and fine setae; Anal plate bilobed, each lobe with 13 setae.

Materials examined. 1 alate viviparous female, Shikaoi-cho, Hokkaido, Japan, 4.ix.2005, Coll JP5, on *Quercus dentata*, collector unknown, CALS SNU.

Host plant. Quercus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On upperside of leaves.

Distribution. Korea, Buthan, China, India, Japan and Eastern Siberia.

Remarks. This species was firstly recorded by Quednau (1979) based on North Korean specimens. However, North Korean specimens were not available. This species was not collected from South Korea. I used Japanese specimens in this study.

***Tuberculatus* (*Orientuberculoides*) *paranacola* Hille Ris Lambers, 1974 신갈낙타진딧물**

Tuberculatus (*Orientuberculoides*) *paranaracola* Hille Ris Lambers, 1974: 23, 32, 75; Quednau, 1979: 507; Quednau and Shaposhnikov, 1988: 1027; Remaudière and Remaudière, 1997: 229; Quednau, 1999: 38.

Tuberculatus paranaracola Pashtshenko, 1981: 36.

Diagnosis. This species is morphologically similar to *T.* (*O.*) *kashiwae* by having no finger like spinal tubercles on pronotum but can be distinguished by having capitated setae on body parts and longer length of spinal tubercle on abdominal tergite.

Description. Alate viviparous female. Color in iife. Not available. *Morphology* (Table S35; Fig. S35). Body oval, 1.82-2.44 mm long, Head slightly wrinkled with 0.08-0.09mm long and capitated seate on small elevations, epicranial suture absent, antennal tubercle developed; Antenna 6-segmented, 0.83-0.93 times as long as body length, inner margin of Ant.I bulging, Ant.I-II faintly imblicated, Ant.III-VI imblicated, antennal setae blunted or pointed, Ant.III with 6-9 rounded secondary rhinaria in a row on basal 2/3, longest setae on Ant.III 0.67-1.00 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT 1.57-1.95 times as long as Ant.VIb, Ant.VIb with 0.01mm of 1 hair like seta; Rostrum not reaching to middle coxae, URS 0.08-0.11mm long with 5-7 accessory setae, 0.67-0.82 times as long as 2HT; Longest setae on HTB 0.80-1.33 times as long as middle width of HTB, hind first tarsal chaetotaxy 7; Pronotum without conspicuous tubercle, with a pair of elevation, meso- and metanotum without tubercles; Abdominal dorsal tergite I-III with a pair of finger-like tubercles bearing 1-2 blunted setae, longest tubercle on abdominal tergite III 0.05-0.07mm long; abdominal tergite VIII with 4-6 setae, abdominal margin I-IV with 2-5 blunted setae on tubercles, spicules developed; SIPH cylindrical 0.09-0.12mm long, tip of SIPH slightly pigmented, with distal flange; Cauda knobbed, 0.09-0.13mm with 11-13 setae; Anal plate bilobed each lobe with 9-14 setae.

Materials examined. 1 alate viviparous female, Suwon, GG, South Korea, 22.v.1967, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Daegwanryeong-myeon, Pyeongchang-gun, GW, South Korea, 11-20.viii.1967, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Suwon, GG, South Korea, 20-25.v.1968, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Suwon, GG, South Korea, 20-16.vi.1968, Coll unknown, on *Quercus aliena*, W.H. Paik, NAAS; 1 alate viviparous female, Hwaseong-si, GG, South Korea, 1-10.vii.1970, Coll unknown, on *Quercus aliena*, W.H. Paik, NAAS; 1 alate viviparous female, Suwon-si, GG, South Korea, 11-20.vii.1970, Coll unknown, on *Quercus aliena*, W.H. Paik, NAAS; 1 alate viviparous female, Konminmyo, Gyeaseong-si, North Korea, 1.vii.1987, Coll 87HA2106, on *Quercus serrata*, J. Havelka, NAAS; 1 alate viviparous female, Okyu-valley, Mt. Geumgangsan, North Korea, 18.v.1988, Coll 88HA2461, on *Quercus mongolica*, J. Havelka, NAAS; 1 alate viviparous female, Hangyearyeong, Yangyang-gun, GW, South Korea, 4.vi.1999, Coll 990602-SH64, on *Quercus* sp., S. Lee, NAAS.

Host plant. Quercus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On upperside of leaves.

Distribution. Korea, China, Japan and Eastern Siberia.

Remarks. This species was identified as *Tuberculatus* (*Orientuberculoides*) *kashiwae* (Matsumura, 1917) by Paik (1972).

***Tuberculatus* (*Orientuberculoides*) *querciformosanus* (Takahashi, 1921) 대만낙타진딧물**

Myzocallis querciformosanus Takahashi, 1921: 70, 72; 1923: 120; 1924: 713.

Recticallis querciformosanus Takahashi, 1923: 120.

Tuberculoides capitata Tao, 1964: 215.

Tuberculatus (*Tuberculatus*) *querciformosanus* Richards, 1968: 586; 1969: 52.

Tuberculatus querciformosanus Higuchi, 1969: 118; 1972: 49.

Tuberculatus (*Orientuberculoides*) *querciformosanus* Eastop and Hille Ris Lambers, 1976: 292; Remaudière and Remaudière, 1997: 229; Quednau, 1999: 37; Quednau, 2003: 295.

Diagnosis. This species can be easily distinguished from congeneric species by having very long and slend shaped URS, 0.16-0.18mm long.

Description. Alate viviparous female. Color in iife. Not available. *Morphology* (Table S36; Fig. S36). Body oval, 1.69-2.64 mm long; Head slightly wrinkled with 0.11-0.14mm long and capitated seate on small elevations, epicranial suture absent, antennal tubercle developed; Antenna 6-segmented, 0.72-1.01 times as long as body length, inner margin of Ant.I bulging, Ant.I-II faintly imblicated, Ant.III-VI imblicated, antennal setae capitated, Ant.III with 3-4 rounded secondary rhinaria in a row on basal half, longest setae on Ant.III 1.00-1.67 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT 1.90-2.29 times as long as Ant.VIb, Ant.VIb with 0.01mm of 1 hair like seta; Rostrum reaching to middle coxae, URS long and slender, 0.16-0.18mm long with 7-10 accessory setae, 2.57-3.40 times as long as 2HT; Longest setae on HTB 1.00-1.25 times as long as middle width of HTB, hind first tarsal chaetotaxy 7; Pronotum with a pair of finger like tubercle, meso- and metanotum without tubercles; Abdominal dorsal tergite I-III with a pair of finger-like tubercles bearing 2-3 blunted setae, longest tubercle on abdominal tergite III 0.16-0.24mm long; abdominal tergite VIII with 3-4 setae, abdominal margin I-IV with 2-4 capitated setae on sclerotized tubercles, wax gland pores and spicules developed; SIPH cylindrical 0.10-0.12mm long, pigmented with distal flange; Cauda knobbed, 0.15-0.18mm with 15-21 setae; Anal plate bilobed, each lobe with 11-12 setae.

Materials examined. 2 alate viviparous females, Sosa, GG, South Korea, 11-20.v.1970, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Suwon-si, GG, South Korea, 11-20.v.1970, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Suwon-si, GG, South Korea, 30.v.1971, Coll 3069A, on *Quercus aliena*, W.H. Paik, NAAS.

Host plant. Quercus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On upperside of leaves.

Distribution. Korea, China, Japan, Taiwan and Eastern Siberia.

***Tuberculatus* (*Orientuberculoides*) *richardsi* Lee, sp. nov.**
닮은갈참나무낙타진딧물 (신칭)

Diagnosis. This species is morphologically very similar to *T*. (*O*.) *kashiwae* (Matsumura) but can be distinguished by having shorter length of URS and 3rd dorsal tubercle poorly developed.

Description. Alate viviparous female. Color in iife. Body pale to pale yellow, dorsal abdominal tubercles and marginal tubercles pale; Head and thorax concolorous with body, antennae pale; Ant.I slightly pigmented, distal joint of Ant.III-IVb dark banded; Legs pale; Wing veins of fore wing inconspicuous or slightly fuscous; Cauda pale, tip of SIPH pigmented. *Morphology* (Table S37; Fig. S37). Body oval, 1.82-2.71 mm long; Head slightly wrinkled with 0.04-0.11mm long and blunted seate on small elevations, epicranial suture absent, antennal tubercle developed; Antenna 6-segmented, slightly shorter than body length, 0.84-1.04 times as long as body length, inner margin of Ant.I bulging, Ant.I-III faintly imblicated, Ant.IV-VI imblicated, antennal setae on Ant.I-III short and slightly blunted, Ant.III with 4-8 rounded secondary rhinaria in a row on basal half, longest setae on Ant.III 0.33-0.67 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT 1.12-1.78 times as long as Ant.VIb, Ant.VIb with 0.01mm of 1 hair like seta; Rostrum not reaching to middle coxae, URS 0.08-0.12mm long with 7-8 accessory setae, 0.79-1.00 times as long as 2HT; Longest setae on HTB 1.00-1.33 times as long as middle width of HTB, hind first tarsal chaetotaxy 6; Pronotum with a pair of tubercle, meso- and metanotum without tubercles; Abdominal dorsal tergite I-III with a pair of 0.04-0.17mm tubercles bearing 1-2 setae, abdominal tergite VIII with 4-7 spinal setae; abdominal margin I-V with elevations, abdominal margin IV with well developed tubercles bearing 3-5 setae; tip of SIPH slightly pigmented, 0.05-

0.16mm long with distal flange; Cauda knobbed, 0.10-0.15mm with 13-16 long and fine setae; Anal plate bilobed, each lobe with 10-17 setae.

Types. Holotype. 1 alate viviparous female, Mt. Hambaeksan, Taebeak-si, GW, South Korea, 8.ix.2013, Coll 130908YR-3, on *Quercus* sp., Y. Lee & H. Lee, CALS SNU; Paratypes. 8 alate viviparous females, same data as the holotype; 4 alate viviparous females, Seoul National Univ. Seoul, South Korea, 19.iv.2009, Coll 090419HJ-1, on *Quercus* sp., H. Kim, CALS SNU; 10 alate viviparous females, Seoul National Univ. Seoul, South Korea, 28.x.2013, Coll 131028YR-1, on *Quercus* sp., Y. Lee & H. Lee, CALS SNU; 7 alate viviparous females, Seoul National Univ. Seoul, South Korea, 26.iv.2014, Coll 140426YR-10, on *Quercus* sp., Y. Lee & H. Lee, CALS SNU;

Host plant. Quercus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On upperside of leaves.

Distribution. Korea and Japan.

Etymology. The species name, *richardsi*, is derived from Canadian aphidologist’s name Richards.

Remarks. This species is newly recorded from Korea.

***Tuberculatus* (*Orientuberculoides*) *silvae* Lee, sp. nov. 참나무동양알락진딧물 (신칭)**

Diagnosis. This species is morphologically very similar to *T*. (*O*.) *higuchii* Hille Ris Lambers but can be distinguished by having longer length of Ant.III-VI and longer lenth of antennal setae on Ant.III.

Description. Alate viviparous female. Color in iife. Body pale to pale yellow, dorsal abdominal tubercles and marginal tubercles pale, head and thorax concolorous with body, antennae pale, Ant.I-II pale, distal joint of Ant.III-IVb dark banded; femur pale, tibiae and tarsus dark; Wing veins of fore wing dark; Cauda pale, tip of SIPH pigmented. *Morphology* (Table S38; Fig. S38). Body oval, 1.98-2.94 mm long; Head slightly wrinkled with 0.10-0.12mm long and blunted seate on small elevations, epicranial suture absent, antennal tubercle developed; Antenna 6-segmented, 0.85-1.23 times as long as body length, inner margin of Ant.I bulging, Ant.I-III faintly imblicated, Ant.IV-VI imblicated, antennal setae on Ant.I-III blunted or pointed shaped, Ant.III with 5-7 rounded secondary rhinaria in a row on basal 3/5, longest setae on Ant.III 0.67-1.00 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT 1.15-1.48 times as long as Ant.VIb, Ant.VIb with 0.01mm of 1 hair like seta; Rostrum not reaching to middle coxae, URS 0.11-0.12mm long with 7-8 accessory setae, 0.73-1.00 times as long as 2HT; Longest setae on HTB 1.00-1.67 times as long as middle width of HTB, hind first tarsal chaetotaxy 6; Pronotum with a pair of 0.06-0.09mm of tubercle, meso- and metanotum without tubercles; Abdominal dorsal tergite I-III with a pair of 0.08-0.17mm tubercles bearing 1-2 setae, abdominal tergite VIII with 5-8 setae, abdominal margin I-V with well developed tubercles bearing 4-5 setae; Tip of SIPH pigmented with spicules, 0.10-0.14mm long with distal flange; Cauda knobbed, 0.12-0.15mm with 9-15 long and fine setae; Anal plate bilobed, each lobe with 11-15 setae.

Types. Holotype. 1 alate viviparous female, Sinwon-ri, Yongin-si, GG, South Korea, 16.v.2014, Coll 140516YR-15, on *Quercus* sp., Y. Lee, CALS SNU; Paratypes. 11 alate viviparous female, same data as the holotype; 5 alate viviparous females, unrecorded, GB, South Korea, 18.v.2005, Coll 050518SH-69, on *Quercus* sp., S. Lee, CALS SNU; 1 alate viviparous female, Chiak recreational forest, GW, South Korea, 20.viii.2013, Coll 130820YR-14, on *Quercus* sp., Y. Lee, CALS SNU; 12 alate viviparous females, SNU-arboretum, Suwon-si, South Korea, 30.iv.2014, Coll 140430YR-6, on *Quercus* sp., Y. Lee, CALS SNU; 1 alate viviparous female, Is. Gureobdo, GG, Incheon-si, 6.v.2014, Coll 140506YR-3, on *Quercus* sp., Y. Lee & H. Lee, CALS SNU; 8 alate viviparous females, Beobheung-ri, Yeongwol-gun, GW, South Korea, 3.vi.2014, Coll 140603JG-1, on *Quercus* sp., J. Jung, CALS SNU;

Host plant. Quercus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On upperside of leaves.

Distribution. Korea.

Etymology. The species name, *silvae*, is derived from Latin noun, ‘silva’ (wood, forest).

Remarks. This species is newly recognized from Korea.

***Tuberculatus* (*Orientuberculoides*) *yaoi* Lee, sp. nov. 숨은동양알락진딧물 (신칭)**

Diagnosis. This species is morphologically very similar to *T.* (*O.*) *higuchii* but can be recognized having 3 setae on fronsal margin, shorter length of SIPH.

Description. Alate viviparous female. Color in iife. Body pale to paleyellow, dorsal abdominal tubercles and marginal tubercles pale; Head and thorax concolorous with body; Antenna pale, distal joint of Ant.III-IV dark banded; Legs pale; Wing veins of fore wing slightly fuscous; Cauda and SPIH pale. *Morphology* (Table S39; Fig. S39). Body oval, 1.75-2.51 mm long; Head slightly wrinkled with 0.04-0.11mm long and pointed or slightly blunted seate on small elevations, epicranial suture absent, antennal tubercle developed; Antenna 6-segmented, slightly shorter than body, 0.82-0.97 times as long as body length, Ant.I-III faintly imblicated, Ant.IV-VI imblicated, antennal setae on Ant.I-IV short and pointed, Ant.III with 3-7 rounded secondary rhinaria in a row on 1/3, longest setae on Ant.III 0.33-0.67 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT 1.18-1.94 times as long as Ant.VIb, Ant.VIb with 0.01mm of 1 hair like seta; Rostrum not reaching to middle coxae, URS 0.08-0.12mm long with 6-9 accessory setae, 0.73-0.92 times as long as 2HT; Longest setae on HTB 1.00-1.33 times as long as middle width of HTB, hind first tarsal chaetotaxy 6-7; Pronotum with a pair of fingerlike tubercle, meso- and metanotum without tubercles; Abdominal dorsal tergite I-III with a pair of 0.04-0.17mm fingerlike tubercles bearing 1-2 pointed setae, abdominal tergite VIII with 5-9 setae, abdominal margin I-IV with 2-4 pointed setae on well developed tubercles; SIPH 0.07-0.10mm long with distal flange; Cauda knobbed, 0.09-

0.15mm with 13-16 long and fine setae; Anal plate bilobed, each lobe with 13-16 setae.

Types. Holotype. 1 alate viviparous female, Mt. Hambaeksan, Taebeak-si, GW, South Korea,08.ix.2013, Coll 130908YR-3, on *Quercus* sp., Y. Lee & H. Lee, CALS SNU; Paratypes. 23 alate viviparous females, same data as the holotype; 6 alate viviparous females, Seoul National Univ., Gwanak-gu, Seoul,South Korea, 19.iv.2009, Coll 090419HJ-1, on *Quercus* sp., H. Kim, CALS SNU.

Host plant. Quercus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On upperside of leaves.

Distribution. Korea.

Etymology. The species name, *yaoi*, is derived from Japanese aphidologist's name Yao.

Remarks. This species is newly recognized from Korea.

***Tuberculatus* (*Orientuberculoides*) *yokoyamai* (Takahashi, 1923) 남방낙타진딧물**

Myzocallis yokoyamai Takahashi, 1923: 63, 120.

Recticallis yokoyamai Takahashi, 1930: 5.

Tuberculatus (*Tuberculatus*) *yokoyamai* Richards, 1968: 593; 1969: 52.

Tuberculatus yokoyamai Higuchi, 1969: 120; 1972: 49; Pashtshenko, 1981: 38.

Tuberculatus (*Orientuberculoides*) *paranaracola* Hille Ris Lambers, 1974: 23, 80; Eastop and Hille Ris Lambers, 1976: 292; Remaudière and Remaudière, 1997: 229; Quednau, 1999: 39; Quednau, 2003: 292, 295.

Diagnosis. This species is morphologically very similar to *T.* (*O.*) *alba* **sp. nov.** Hille Ris Lambers but can be distinguished by having shorter length of antenna and shorter length of setae on head and antenna.

Description. Alate viviparous female. Color in iife. Body pale to yellow, spinal tubercles on abdominal tergite I-II and marginal tubercles pale, tip of 3rd abdominal tubercle slightly pigmented; Head and thorax concolorous with body; Antenna pale, distal joint of Ant.III-IVb dark banded; Tibiae pigmented; Wing veins of fore wing slightly fuscous; Cauda pale; Tip of SIPH pigmented. *Morphology* (Table S40; Fig. S40). Body oval, 1.77-2.50 mm long; Head slightly wrinkled with 0.05-0.11mm long and blunted seate on small elevations, epicranial suture absent, antennal tubercle developed; Antenna 6-segmented, 0.87-1.08 times as long as body length, inner margin of Ant.I bulging, Ant.I-II faintly imblicated, Ant.III-VI imblicated, antennal setae on Ant.I-IV short and blunted, Ant.III with 5-12 rounded secondary rhinaria in a row on 4/5, longest setae on Ant.III 0.33-0.67 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT 1.19-1.94 times as long as Ant.VIb, Ant.VIb with 0.01mm of 1 hair like seta; Rostrum not reaching to middle coxae, URS 0.09-0.11mm long with 5-8 accessory setae, 0.69-0.92 times as long as 2HT; Longest setae on HTB 1.25-1.33 times as long as middle width of HTB, hind first tarsal chaetotaxy 7; Pronotum with a pair of finger like tubercle, meso- and metanotum without tubercles; Abdominal dorsal tergite I-III with a pair of 0.05-0.16mm finger like tubercles bearing 2-3 setae, abdominal tergite VIII with 5-7 setae, abdominal margin I-IV with 2-5 blunted setae on well developed tubercles; SIPH cylindrical, 0.09-0.12mm long with distal flange; Cauda knobbed, 0.10-0.14mm with 14-16 long and fine setae; Anal plate bilobed, each lobe with 12-15 setae.

Materials examined. 1 alate viviparous female, Seoul, South Korea, 10-20.v.1968, Coll 4516, on *Quercus* sp., W.H. Paik, NAAS; 1 alate viviparous female, Seoul, South Korea, 10-20.v.1968, Coll 4518, on *Quercus* sp., W.H. Paik, NAAS; 1 alate viviparous female, Jochiwon-eub, Sejong-si, CN, South Korea, 30.v.1968, Coll 4656, on *Quercus varialis*, W.H. Paik, NAAS; 1 alate viviparous female, Suwon-si, GG, South Korea, vi.1968, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Seoul, South Korea, 20-25.vi.1968, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Seoul, South Korea, 12.v.1971, Coll 6269, on *Quercus dentata*, W.H. Paik, NAAS; 1 alate viviparous female, Mt. Yonggaksan, Pyeongyang-si, North Korea, 5.vi.1985, Coll 85HA0870, on *Quercus dentate*, J. Havelka, NAAS; 11 alate viviparous female, Tongyeong-si, GN, South Korea, 11.v.2006, Coll 060511HJ-2, on *Quercus* sp., H. Kim, CALS SNU; 5 alate viviparous female, Chusan-research forest, Gwangyang-si, JN, South Korea, 25.vii.2013, Coll 130725YR-11, on *Quercus* sp., Y. Lee, CALS SNU; 21 alate viviparous female, Sinwon-ri, Yongin-si, GG, South Korea, 16.v.2014, Coll 140516YR-1, on *Quercus* sp., Y. Lee, CALS SNU; 7 alate viviparous females, Mt. Ilwolsan, Yeongyang-gun, GB, South Korea, 24.vi.2014, Coll 140624YR-17, on *Quercus* sp., Y. Lee, CALS

SNU; 15 alate viviparous females, Mt. Gwanggyosan, Suwon-si, GG, South Korea, 10.v.2015, Coll 150510YR-2, on *Quercus* sp., Y. Lee & H. Lee, CALS SNU.

Host plant. Quercus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On upperside of leaves.

Distribution. Korea, China, Japan and Eastern Siberia.

Subtribe Panaphidina Oestlund, 1923 애알락진딧물아족

Type genus: *Panaphis* Oestlund, 1923: 135.

Key to the genera of subtribe Panaphidina in Korea

1. Antenna 3 or 5-segmented, hind first tarsal chaetotaxy with 2 setae ***Dasyaphis***

- Antenna 6-segmented, hind first tarsal chaetotaxy with 6-8 setae **2**

2. Cribriformed wax gland pore disc developed on abdominal dorsum and margin .... ***Shivaphis***

- Cribriformed wax gland pore disc not developed on abdominal dorsum and margin **3**

3. Clypeus with a nose like process, rostrum very short barely reaching to fore coxae .... ***Takecallis***

- Clypeus without a nose like process, rostrum passing over fore coxae **4**

4. Head with conspicuous cone shaped median protrusion .... ***Pseudochromaphis***

- Head without conspicuous cone shaped median protrusion **5**

5. PT always much shorter than Ant.VIb **6**

- PT almost same or longer than Ant.VIb.. **8**

6. SIPH without setae, fore wing with extensive brownish dark markings...........
....***Neochromaphis***

- SIPH with setae, fore wing without brownish dark markings **7**

7. Pronotum with 4 discal setae, SIPH with 2-3 setae ....***Chromaphis***

- Pronotum covered with dense setae, SIPH with 4-6 setae .... ***Panaphis***

8. Co and Pts of fore wing entirely black ....***Tiliaphis***

- Co and Pts of fore wing pale or slightly pigmented.. **9**

9. Abdomen with spinal dorsal sclerotises ....***Therioaphis***

- Abdomen without spinal dorsal sclerotises... **10**

10. Fore tibiae black pigmented and thicker than middle and hind tibiae, cu1b of fore wing distinctly dark bordered ....***Mesocallis***

- Fore tibiae normal, not thinker than middle and hind tibiae, cu1b of fore wing dark bordered... **11**

11. Secondary rhinaria on Ant.III always rounded, abdominal dorsum with unpaired spinal tubercle or with spinulate setae...................................***Pterocallis***

- Secondary rhinaria on Ant.III transversely elliptical or slit-like shaped, abdominal dorsum with a pair of spinal tubercle or elevations, never with spinulate setae... **12**

12. SIPH very short pit-like form...***Monelliopsis***

- SIPH cylindrical, longer than its basal diameter... **13**

13. Abdominal dorsum with not arranged setae, abdominal margin with 4-8 marginal setae, marginal tubercle not developed ....***Chromocallis***

- Abdominal dorsum with a pair of spinal setae, a pair of finger like or cone like spinal tubercle always developed on abdominal dorsum I-II, abdominal margin only with a single marginal seta **14**

14. Pronotum with a pair of spinal tubercle, fore wing without extensive dark markings .... ***Tinocallis***

- Pronotum without spinal tubercles, fore wing with extensive dark markings .... ***Sarucallis***

Genus *Chromaphis* Walker, 1870 호두알락진딧물속 (신칭)

Type species: *Lachnus juglandicola* Kaltenbach, 1824: 151.

= *Chromaphis juglandicola* (Kaltenbach, 1843).

Neocalaphis Shinji, 1927: 28.

Diagnosis. This genus is closely related to *Panaphis* Kirkaldy but can be recognized by having 4 discal setae on pronotum and SIPH with 2 setae.

Host plant. Juglans spp.* (Juglandaceae).

Distribution. Afrotropical, Oriental, Palearctic, and Nearctic.

Remarks. Two species are included in this genus in the world. *Chromaphis* species are widely distributed across Europe, Asia, Africa, and North America. Both species are associated with *Juglandis* spp. (Juglandaceae). Apterous viviparous female unknown.

Chromaphis juglandicola **(Kaltenbach, 1824) 호두알락진딧물 (신칭)**

Lachnus juglandicola Kaltenbach, 1824: 151; Kaltenbach, 1874: 97.

Aphis juglandicola Walker, 1848: 343; 1852: 945.

Callipterus juglandicola Passerini, 1860: 33; 1963: 189; Walker, 1868: 1329;

Chromaphis peglandicola Walker, 1870: 2001.

Pterocallis juglandicola Schouteden, 1900: 134.

Diagnosis. This species can be distinguished by the only congeneric species *C. hirsutustibis* Kumar & Lavigne by having two pairs of 0.03-0.04mm pointed setae on abdominal tergite I-V.

Description. Alate viviparous female. Color in iife. Body pale to pale yellow, marginal tubercles pale; Head and thorax concolorous with body; Antennae pale, distal joint of Ant.III-IV dark banded; Legs pale, HFM with dark pigmented spot; Wing veins of fore wing clear cut, slightly dark bordered; Cauda pale and SIPH pale. *Morphology* (Table S41; Fig. S41). Body oval, 1.38-1.91 mm long; Head slightly wrinkled with 0.01-0.03mm short and pointed seate, epicranial suture absent, antennal tubercle reduced; Antenna 6-segmented, 0.49-0.60 times as long as body length, inner margin of Ant.I slightly bulging, Ant.I-III faintly imblicated, Ant.IV-VI imblicated, antennal setae on Ant.I-IV short and almost invisible, Ant.III with 5-9 rounded secondary rhinaria in a row on whole surface, longest setae on Ant.III 0.5 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT shorter than Ant.VIb, 0.18-0.30 times as long as Ant.VIb, Ant.VIb with 0.01mm of 1 hair like seta; Rostrum not reaching to middle coxae, URS 0.06-0.07mm long with 5-6 accessory setae, 0.60-0.88 times as long as 2HT; Longest setae on HTB 1.67-2.33 times as long as middle width of HTB, hind first tarsal chaetotaxy 7; Thorax without tubercles; Abdominal dorsal tergite I-V with two pairs of spinal setae, abdominal tergite VIII with 9-13 setae, abdominal margin I-V with 3-4 setae on marginal tubercle; SIPH cylindrical 0.03-0.06mm long with distal flange bearing 2-3 pointed setae; Cauda knobbed, 0.07-0.08mm with 13-16 setae; Anal plate bilobed, each lobe with 10-13 setae.

Materials examined. 2 alate viviparous females, Taeseongsan Botanical garden, Pyeongyang-si, North Korea, 9.vi.1988, Coll 88HA2938, on *Juglans manshurica*, J. Havelka, NAAS; 5 alate viviparous females, Cheonan samgeori rest area, Cheonan-si, CN, South Korea, 28.vii.2013, Coll 130728YR-1, on *Juglandis sinensis*, Y. Lee, CALS SNU; 2 alate viviparous females, Naehyeon-ri, Seo-myeon, Yangyang-gun, GW, South Korea, 13.viii.2013, Coll 130813YR-1, on *Juglandis* sp., Y. Lee, CALS SNU; 9 alate viviparous females, Uirang-myeon, Gongju-si, CN, South Korea, 24.v.2014, Coll 140525YR-1, on *Juglandis* sp., Y. Lee & H. Lee, CALS SNU; 20 alate viviparous females, Gwangdeok-myeon, Cheonan-si, Gongju-si, CN, South Korea, 24.v.2014, Coll 140525YR-2, on *Juglandis* sp., Y. Lee & H. Lee, CALS SNU; 6 alate viviparous females, Mt. Geomdansan, Hanam-si, GG, South Korea,12.vi.2014, Coll 140612YR-13, on *Juglandis* sp., Y. Lee, CALS SNU.

Host plant. Juglans spp.* (Juglandaceae).

Biology. Monoecius holocyclic lifecycle. On upperside of leaves.

Distribution. Korea, China, India, Pakistan, Central Asia, Middle-East, Europe, North Africa and North America.

Remarks. This species is new to Korea. This species is one of the serious pest on walnut.

Genus *Chromocallis* Takahashi, 1961 초록알락진딧물속

Type species: *Chromaphis nirecola* Shinji, 1933: 210.

= *Chromocallis nirecola* (Shinji, 1933).

Chromacallis Zhang & Zhong, 1985: 221.

Diagnosis. This genus is morphologically similar to *Appendiseta* Richards but can be distinguished by having stout body shape, black bordered wing vein of fore wing and not arranged dorsal setae.

Host plant. Ulmus spp.* (Ulmaceae).

Distribution. Palearctic region.

Remarks. This genus is small genus comprising 2 species distributed in East Asia. Both species are associated with *Ulmus* spp. (Ulmaceae). Apterous viviparous female unknown.

Chromocallis nirecola (Shinji, 1933) 초록알락진딧물

Chromaphis nirecola Shinji, 1933: 210.

Chromocallis nirecola Takahashi, 1961: 253; Higuchi, 1972: 21; Eastop and Hille Ris Lambers, 1976: 145; Remaudière and Remaudière, 1997: 215; Quednau, 2003: 24.

Diagnosis. This species can be recognized from the only congeneric species *C. similinirecola* by having longer length of URS bearing 6-7 accessory setae and abdominal setae mostly pointed, rarely capitated.

Description. Alate viviparous female. Color in iife. Body yellowish green; Head concolorous with body, compound eye white; thorax with dark brownish pigmented markings; Ant.I pale, Ant.II-VI pigmented; Legs pigmented, basal 2/3 of femur concolorus with body; Wing veins of fore wing dark bordered; Cauda pale and SIPH pale green. *Morphology* (Table S42; Fig. S42). Body stout oval, 2.74-3.03 mm long; Head slightly wrinkled with 0.02-0.03mm pointed seate, epicranial suture poorly developed, antennal tubercle developed; Antenna 6-segmented, about half length of body, 0.52-0.60 times as long as body length, inner margin of Ant.I slightly bulging, Ant.I-III faintly imblicated, Ant.IV-VI imblicated, Ant.III with 13-21 transversely elliptical secondary rhinaria in a whole surface, longest setae on Ant.III same with BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT shorter than Ant.VIb, 0.41-0.50 times as long as Ant.VIb, Ant.VIb with 0.01mm of 1 hair like seta; Rostrum not reaching to middle coxae, URS 0.11-0.14mm long with 6-7 accessory setae, 0.79-0.10 times as long as 2HT; Longest setae on HTB 1.83-2.50 times as long as middle width of HTB, hind first tarsal chaetotaxy 7; Prothorax with two pairs of short pointed setae on elevations, meso- and metanotum without tubercles; Abdominal dorsal setae not arranged some setae on small elevations, adominal tergite VIII with 9-13 pointed setae, abdominal margin with 9-14 setae on broadly developed elevation; SIPH cylindrical 0.09-0.13mm long with moderate distal flanged; Cauda knobbed, transversely elongated shaped, 0.15-0.18mm with 19-22 long and fine setae; Anal plate bilobed, each lobe with 11-14 setae.

Materials examined. 2 alate viviparous females, Seoul, South Korea, 19.vi.1968, Coll unknown, on *Ulmus cavidiana*, W.H. Paik, NAAS; 2 alate viviparous females, Seoul, South Korea, 30.vi.1968, Coll 4721, on *Ulmus cavidiana*, W.H. Paik, NAAS; 6 alate viviparous females, Sangdong, Yeongwol-gun, GW, South Korea, 12.vi.2014, Coll 140612YR-13, on *Ulmus* sp., Y. Lee, CALS SNU.

Host plant. Ulmus spp.* (Ulmaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, China, Japan and Eastern Siberia

Remarks. This species is relatively rare species only occur on *Ulmus* spp.

Genus *Dasyaphis* Takahashi, 1938 납작가시진딧물속

Type species: *Tuberocorpus onigurumi* (Shinji, 1932): 120.

= *Dasyaphis rhusae* (Shinji, 1922): 128-129.

Sinocallis Tseng & Tao, 1938: 213.

Tuberocorpus Paik, 1965: 46.

Daysaphis Zhang, Zhong & Zhang, 1992: 146.

Diagnosis. This genus is easily recognized by having 3 or 5-segmented short antenna, URS without accessory setae and 2 hind first tarsal chaetotaxy.

Host plant. Juglans spp.* (Juglandaceae).

Distribution. Palearctic region.

Remarks. This genus is small genus comprising 2 species in the world. *Dasyaphis* species are only distributed in East Asia. All species are associated with *Jugland* spp. (Juglandaceae). Apterous viviparous female commonly occur.

Dasyaphis rhusae (Shinji, 1922) 납작가시진딧물

Glyphina rhusae Shinji, 1922: 128-129.

Tuberocorpus onigurumi Shinji, 1932: 120.

Tuberocorpus coreanus Paik, 1965: 46.

Dasyaphis rhusae Eastop and Hille Ris Lambers, 1976: 207; Quednau, 1979: 507; Remaudière and Remaudière, 1997: 216; Quednau, 2003: 15.

Diagnosis. This species is morphologically distinguished by having sausage shaped dorsal tubercles as long as antenna.

Description. Apterous viviparous female. Color in iife. Body pale to pale yellow; Head and thorax concolorous with body, compound eye red; Antennae pale; Legs pale, Cauda pale and SIPH pale. *Morphology* (Table S43; Fig. S43). Body flattened, 1.15-1.33 mm long; Head fused with prothorax, head surface sculptured with 0.04-0.07mm spinulate setae, epicranial suture poorly developed, antennal tubercle absent; Antenna 3 segmented, 0.17-0.20 times as long as body length, Ant.I-II faintly imblicated, Ant.III imblicated, Ant.III without secondary rhinaria, longest setae on Ant.III 0.5 times as long as with BDAnt.III, Ant.III with imperceptibly ciliated small and rounded primary rhinaria, PT much shorter than basal segment of Ant.III, 0.07-0.15 times as long as basal segment of Ant.III, Ant.III with 0.01mm of 2-5 hair like seta; Rostrum reaching to fore coxae, URS 0.03-0.05mm long without accessory setae, 0.50-0.83 times as long as 2HT; Longest setae on HTB 0.20-0.33 times as long as middle width of HTB, hind first tarsal chaetotaxy 2; Thorax and dorsal tergite I-VI with 0.12-0.25mm long and sussage like tubercles, each tubercle with a single long spinulate seta, abdominal tergite VIII with 9-10 setae, abdominal margin I-VIII with 0.06-0.08mm spinule setae, dorsal surface sculptured; SIPH small sized pori-form with 0.02mm diameter; Cauda knobbed, 0.07-0.10mm with 10-20 setae; Anal plate bilobed, each lobe 6-10 setae.

Materials examined. 1 alate viviparous female, Seoul, South Korea, 17.ix.1963, Coll 2743, on *Juglans manshurica*, W.H. Paik, NAAS; 8 alate viviparous females, Seoul, South Korea, 8.vi.1971, Coll 6403, host plant unknown, W.H. Paik, NAAS; 14 apterous viviparous females, Mt. Baegunsan, Gwangyang, JN, South Korea, 25.vii.2013, Coll 130725YR-21, on *Juglans mandshurica*, Y. Lee, CALS SNU; 6 apterous viviparous females, Yongdae-recreation forest, Inje, GW, South Korea, 01.viii.2013, Coll 130801YR-7, on *Juglans mandshurica*, Y. Lee, CALS SNU.

Host plant. Juglans spp.* (Juglandaceae).

Biology. Monoecius holocyclic lifecycle. On upperside of leaves.

Distribution. Korea, China, Japan and Eastern Siberia

Remarks. Alate viviparous female not observed.

Genus *Mesocallis* Matsumura, 1919 노랑알락진딧물속

Type species: *Myzocallis sawashibae* Matsumura, 1917: 374.

= *Mesocallis sawashibae* (Matsumura, 1917): 374.

Diagnosis. This genus is morphologically similar to *Pterocallis* Passerini but can be distinguished by having 2 setae on abdominal tergite VIII, black bordered fore tibiae and cu1b of fore wing distinctly dark bordered.

Host plant. Alnus spp., *Carpinus* spp.*, *Corylus* spp.* and *Ostrya* spp. (Betulaceae).

Distribution. Oriental and Palearctic region.

Remarks. This genus comprises 8 species under 2 subgenera in the world. *Mesocallis* species are only distributed in Asia. All species are associated with *Betulceae* spp. Apterous viviparous female observed in some species.

Key to the subgenera of *Mesocallis* Matsumura in Korea

1. Abdominal margin with a single pointed seta on abdominal tergite I-IV ....***Mesocallis***

- Abdominal margin with 2-3 setae on abdominal tergite I-IV ......***Paratinocallis***

Subgenus *Mesocallis* Matsumura, 1919 서나무노랑알락진딧물아속

Type species: *Myzocallis sawashibae* Matsumura, 1917: 374.

= *Mesocallis sawashibae* (Matsumura, 1917): 374.

Neocallis Matsumura, 1919: 104.

Nippochaitophorus Takahashi, 1961: 247.

Diagnosis. This subgenus can be recognized by having a single pointed marginal seta on abdominal tergite I-IV.

Host plant. Alnus spp., *Carpinus* spp.*, *Corylus* spp.* and *Ostrya* spp. (Betulaceae).

Distribution. Oriental and Palearctic region.

Remarks. This subgenus comprises 6 species which are only distributed in Asia. All species are associated with Betulaceae spp. Each species is highly host specific.

Key to the species of *Mesocallis* Higuchi in Korea

1. Head vertex and Ant.I-III pale.. ***M.* (*M.*) *sawashibae***

- Head vertex including Ant.I-III blackish **2**

2. PT 0.06-0.08mm long and URS 0.08-0.10mm long..
....***M.* (*M.*) *carpinicola* sp. nov.**

- PT 0.08-0.10mm long and URS 0.11-0.14mm long .... ***M.* (*M.*) *pteleae***

***Mesocallis* (*Mesocallis*) *carpinicola* Lee, sp. nov. 서나무검은줄알락진딧물 (신칭)**

Diagnosis. This species is morphologically similar to *M.* (*M.*) *pteleae* Matsumura by having blackish head vertex and Ant.I-III but can be distinguished by having shorter length of PT and URS, URS with 3-6 accessory setae.

Description. Alate viviparous female. Color in iife. Head pale yellow, head vertax and Ant.I-III fuscous, compound eye red, distal joint of Ant.IV-VIb and distal 1/2 of PTdark; Thorax and abdomen pale yellow; Legs pale, fore and hind tibiae including 1/9 of femur and all tarsi black, 1/9 of middle tibiae and tarsi dark; cu1b of fore wing, black bordered; SIPH and cauda pale. *Morphology* (Table S44; Fig. S44). Body oval, 1.3-1.55mm long; Head smooth with a flat median protrusion on frons, head vertax with 0.01mm pointed setae, epicranial suture weakly developed, head dorsum without tubercles; Antenna 6-segmented, 0.66-0.78 times as long as body length, Ant.III with 12-15 narrow transversely elliptical secondary rhinaria in a row on the whole segment, with 4-5 short and pointed setae, Ant.III-VI imbricated with inconspicuous setae, Ant.IV without secondary rhinaria, PT 0.6-0.8 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.10-0.11mm long with 4-6 accessory setae, 1.22-1.38 times as long as 2HT; Thorax smooth, without tubercles; Fore coxae weakly enlarged, longest setae on HTB 0.67-1.00 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.08-0.09mm long; Rs of fore wing weakly developed; Dorsal abdominal setae sometimes on small elevations but conspicuous tubercles not developed, abdominal tergite VIII with a pair of spinal setae abdominal marginal tergite I-IV with with a single setae on short cone-shaped tubercles; SIPH cylindrical, truncated, 0.05-0.06mm long; Cauda knobbed, 0.07-0.09mm long, bearing 10-15 setae; Anal plate bilobed, each lobe with 7-8 setae.

Types. Holotype. 1 alate viviparous female, Jangsan-forest, Jangsan-ri, Maam-myeon, Goseong-gun, GN, South Korea, 3.v.2015, Coll 150503YR-11, on *Carpinus laxiflora*, Y. Lee & H. Lee, CALS SNU; Paratypes. 19 alate viviparous females, same data as the holotype.

*Host plant. Carpinus laxiflora** (Betulaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea.

Etymology. The species name, *carpinicola*, is derived from the genus name of host plant (*Capinus*) and the Latin suffix, '-cola' (dweller, inhabitant).

Remarks. This species is newly recognized from Korea.

***Mesocallis* (*Mesocallis*) *pteleae* Matsumura, 1919 검은줄알락진딧물 (신칭)**

Mesocallis pteleae Matsumura, 1919: 103; Higuchi, 1972: 23.

Agrioaphis corylicola Shinji, 1935: 284.

Agrioaphis hashibamii Shinji, 1935: 284.

Mesocallis (*Mesocallis*) *pteleae* Quednau, 2003: 20.

Diagnosis. This species is morphologically close to *M*. (*M*.) *carpinicola* Lee, **sp. nov.** However, it differs in having longer length of PT and long and slender shaped URS, URS with 8-10 accessory setae.

Description. Alate viviparous female. Color in iife. Head pale, head vertax and Ant.I-III fuscous, compound eye red, distal joint of Ant.IV-V, Ant.VIb and distal 1/2 of PT also dark; Thorax and abdomen pale; Legs pale, fore tibiae including 1/9 of femur black, distal margin of HFM dark, tarsi dark; cu1b of fore wing dark bordered; SIPH and cauda pale. *Morphology* (Table S45; Fig. S45).

Body oval 1.51-1.76mm long; Head smooth with a flat median protrusion on frons, head vertax with 0.01mm pointed setae, epicranial suture developed, head dorsum without tubercles; Antennae 6-segmented, 0.63-0.74 times as long as body length, Ant.III with 13-16 transversely elliptical secondary rhinaria in a row on the whole segment, Ant.III with 8-10 short pointed setae, Ant.III-VI imbricated, Ant.IV without secondary rhinaria, Ant.VIb with a single inconspicuous seta, PT 0.71-0.91 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.11-0.14mm long with 8-9 accessory setae, 1.22-1.50 times as long as 2HT; Thorax smooth, without tubercles; Fore coxae weakly enlarged, longest setae HTB 1.00-1.05 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.08-0.10mm long; Rs of fore wing weakly developed; Dorsal abdominal setae sometimes on small elevations but conspicuous tubercles not developed, abdominal tergite VIII with a pair of spinal setae, rarely with 3 setae, abdominal marginal tergite I-IV with a single setae on short cone-shaped tubercles, 4th marginal tubercle 0.02mm long; SIPH cylindrical, truncated, 0.03-0.06mm long; Cauda knobbed, 0.09-0.11mm long, bearing 8-11 setae; Anal plate bilobed, each lobe with 7-10 setae.

Materials examined. 33 alate viviparous females, Mt. Chilgapsan, Cheongyang-gun, CN, South Korea, 10.v.2014, Coll 140510YR-1, on *Corylus* sp., Y. Lee & H. Lee, CALS SNU.

Host plant. Corylus sp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, China and Japan.

Remarks. This species is new to Korea.

***Mesocallis* (*Mesocallis*) *sawashibae* (Matsumura, 1917)**

서나무노랑알락진딧물

Myzocallis sawashibae Matsumura, 1917: 374;

Mesocallis sawashibae Matsumura, 1919: 103; Higuchi, 1972: 24; Quednau and Shaposhnikov, 1988: 1027; Remaudière and Remaudière, 1997: 217.

Neocallis carpinicola Matsumura, 1919: 104;

Nippochaitophorus moriokaensis Takahashi, 1961: 247.

Pterocallis (*Mesocallis*) *sawashibae* Eastop and Hille Ris Lambers, 1976: 292, 368.

Mesocallis (*Mesocallis*) *sawashibae* Quednau, 2003: 20.

Diagnosis. This species is morphologically close to *Mesocallis* (*M*.) *obtusirostris* Gosh by having pale head and body, and partly pigmented antennae. However, it can be distinguished by having 6-12 secondary rhinaria in a row on basal 2/3 of Ant.III (*M*. (*M*.) *obtusirostris*, Ant.III with 4-7 secondary rhinaria restricted on the basal half).

Description. Alate viviparous female. Color in iife. Head and antenna pale yellow, distal joint of Ant.III-VIb dark, compound eye red; Thorax and abdomen pale yellow; Legs pale; cu1b of fore wing, slightly dark bordered; SIPH and cauda. *Morphology* (Table S46; Fig. S46). Body oval, 1.27-1.77mm long; Head smooth with a flat median protrusion on frons, head vertax with 0.01mm pointed setae, epicranial suture weakly developed, head dorsum without tubercles; Antenna 6-segmented, 0.64-0.76 times as long as body length, Ant.III with 6-12 transversely elliptical secondary rhinaria in a row on 2/3 of segment, bearing 6-11 short pointed setae, Ant.IV-VI imbricated with inconspicuous hairlike setae, Ant.IV without secondary rhinaria, Ant.VIb with a single inconspicuous seta, PT 0.80-1.25 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.06-0.08mm long with 4-5 accessory setae, 0.67-1.00 times as long as 2HT; Fore coxae weakly enlarged, longest setae on HTB 0.67-1.00 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.08-0.10mm long; Rs of fore wing weakly developed; Thorax smooth, without tubercles; Dorsal abdominal setae sometimes on small elevations but conspicuous tubercles not developed, abdominal tergite VIII with a pair of spinal setae, abdominal marginal tergite I-IV with a single seta on short cone-shaped tubercles, 4th marginal tubercle 0.02-0.04mm long; SIPH cylindrical, truncated, 0.04-0.06mm long; Cauda knobbed, 0.08-0.11mm long, bearing 11-13 setae; Anal plate bilobed, each lobe with 5-10 setae.

Materials examined. 4 alate viviparous females, Seoul, South Korea, 3.xi.1970, Coll 6146, on *Carpinus erosa*, W.H. Paik, NAAS; 1 alate viviparous female, Seoul, South Korea, 6.v.1971, Coll 6241, on *Carpinus koreana*, W.H. Paik, NAAS; 1 alate viviparous female, Seoul, South Korea, 6.v.1971, Coll 6247, on *Carpinus erosa*, W.H. Paik, NAAS; 1 alate viviparous female, Seoul, South Korea, 21.x.1971, Coll 6837, on *Carpinus cordata*, W.H. Paik, NAAS; 2 alate viviparous females, Manmulsang-area, Mt. Geumgangsan, North Korea, 24.v.1988, Coll 88HA2587, on *Carpinus cordata*, J. Havelka, NAAS; 3 alate viviparous females, Mt. Baegunsan, Gwangyang-si, JN, South Korea, 25.vii.2013, Coll 130725YR-23, on *Corylus* sp., Y. Lee, CALS SNU; 1 alate viviparous female, Gwangreung-national arboretum, Pocheon-si, GG, South Korea, 2.viii.2013, Coll 130802YR-3, on *Carpinus tschonoski*, Y. Lee, CALS SNU; 2 alate viviparous females, Inje-gun, GW, South Korea, 26.ix.2013, Coll 130926Ram-6, on *Carpinus* sp., D.K. Ram, CALS SNU; 10 alate viviparous females, Mt. Manisan, Is. Ganghwado, Incheon-si, GG, South Korea, 17.v.2014, Coll 140517YR-1, on *Carpinus* sp., Y. Lee & H. Lee, CALS SNU; 33 alate viviparous females, Yongdae-ri, Inje-gun, GW, South Korea, 4.vi.2014, Coll 140604YR-42, on *Carpinus* sp., Y. Lee, CALS SNU; 13 alate viviparous females, Mt. Manisan, Is. Ganghwad, Incheon-si, GG, South Korea, 21.vi.2014, Coll 140621YR-3, on *Carpinus* sp., Y. Lee & H. Lee, CALS SNU.

Host plant. Carpinus spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, China, Japan and Eastern Siberia.

Subgenus *Paratinocallis* Higuchi, 1972 흰개암알락진딧물속 (신칭)

Type species: *Paratinocallis corylicola* Higuchi, 1972: 30.

Neocallis Matsumura, 1919: 104.

Nippochaitophorus Takahashi, 1961: 247.

Diagnosis. This subgenus can be easilly distinguished from the subgenus *Mesocallis* by having 2-3 hairs on abdominal marginal tubercles.

Host plant. Corylus spp.* (Betulaceae).

Distribution. Palearctic region.

Remarks. This subgenus comprises 2 species which are only distributed in East-Asia (Korea, China, Japan and Eastern Siberia). All species are associated with *Corylus* spp. (Betulaceae).

Key to the species of *Paratinocallis* Higuchi in Korea

1. URS 0.80-0.10 times as long as 2HT .... ***M.* (*P.*) *corylicola***
2. URS 0.10-0.14 times as long as 2HT .... ***M.* (*P.*) *occultus***

***Mesocallis* (*Paratinocallis*) *corylicola* (Higuchi, 1972) 흰개암알락진딧물 (신칭)**

Paratinocallis corylicola Higuchi, 1972: 30; Quednau and Shaposhnikov, 1988: 1028; Remaudière and Remaudière, 1997: 222.

Pterocallis (*Paratinocallis*) *corylicola* Eastop and Hille Ris Lambers, 1976: 337, 338; Quednau, 1979: 509.

Mesocallis (*Paratinocallis*) *corylicola* Quednau, 2003: 21.

Diagnosis. This species is morphologically close to *Mesocallis yunanensis* (Zhang) but can be distinguished by having pointed setae on dorsal abdomen (*M. yunanensis* has neotenic formed setae), URS 0.80-1.00 times as long as 2HT (*M. yunanensis*, 1.5-1.7), and PT 0.90-1.10 times as long as Ant.VIb (*M. yunanensis* 0.6-0.7).

Description. Alate viviparous female. Color in iife. Head and antenna pale yellow, distal joint of Ant.III-VIb dark; Thorax and abdomen pale yellow; Legs pale, distal 1/3 of fore tibiae and tarsi fuscous; cu1b of fore wing dark bordered; SIPH and cauda. *Morphology* (Table S47; Fig. S47). Body oval, 1.24-1.61mm; Head smooth with a flat median protrusion on frons, epicranial suture weakly indicated, head vertax with 0.01mm pointed setae, head dorsum without tubercles; Antenna 6-segmented, 1.02-1.29 times as long as body length, Ant.III with 7-12 transversely elliptical formed secondary rhinaria in a row on the whole segment, Ant.III-VI imbricated with inconspicuous hairlike setae, Ant.IV without secondary rhinaria, PT 0.92-1.10 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.08-0.09mm long with 4-5 accessory setae, 0.80-1.00 times as long as 2HT; Thorax smooth, without tubercles; Fore coxae weakly enlarged, longest setae on HTB 1.00-1.50 times as long as middle width of HTB, first segment of hind tarsi with 7-8 chaetotaxy, 2HT 0.08-0.11mm long; Dorsal abdominal setae sometimes on small elevations but conspicuous tubercles not developed, abdominal tergite VIII with a pair of setae, abdominal marginal tergite I-IV with 2 setae on short cone-shaped tubercles; SIPH cylindrical, truncated, 0.05-0.07mm long; Cauda knobbed, 0.08-0.10mm long, bearing 10-14 setae; Anal plate bilobed, each lobe with 6-11 setae.

Materials examined. 1 alate viviparous female, Mt. Gyeryongsan, Gyeryong-si, CN, South Korea, 17.ix.1963, Coll 2103, on *Alnus japonica*, W.H. Paik, NAAS; 1 alate viviparous female, Daegwanryeong-myeon, Pyeongchang-gun, GW, South Korea, 11-20.viii.1968, Coll unknown, host plant unknown, W.H. Paik, NAAS; 3 alate viviparous females, Seoul, South Korea, 12.v.1971, Coll 6268, on *Physocarpus insularis*, W.H. Paik, NAAS; 1 alate viviparous female, Mt. Myohyangsan, PB, North Korea, 15.vi.1985, Coll 85HA0789, on *Corylus heterophylla*, J. Havelka, NAAS; 3 alate viviparous females, Mt. Baekdusan, Naegok-ri, YG, North Korea, 18.vi.1988, Coll 88HA3031, on *Corylus heterophylla*, J. Havelka, NAAS; 1 alate viviparous female, Danseong-myeon, Danyang-gun, CB, 18.v.2001, Coll 011517-SH22, on *Corylus* sp., S. Lee, NAAS; 10 alate viviparous females, Sinwon-ri, Yongin-si, GG, South Korea, 16.v.2014, Coll 140516YR-12, on *Corylus* sp., Y. Lee, CALS SNU; 30 alate viviparous females, Mt. Hwayasan, Gapyeong-gun, GG, South Korea, 26.v.2014, Coll 140526YR-1, on *Corylus* sp., Y. Lee, CALS SNU.

Host plant. Corylus spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea.

Mesocallis (_Paratinocallis_) _occultus_ Lee, sp. nov. 우리흰개암알락진딧물 (신칭)

Diagnosis. This species is morphologically very similar to *M.* (*P.*) *corylicola* Higuchi by having pale body and URS 0.07-0.09mm long. However, it can be distinguished by relative length of antenna and body and the ratio of URS and 2HT.

Description. Alate viviparous female. Color in iife. Head and antenna pale yellow, distal joint of Ant.III-VIb; Thorax and abdomen pale yellow; Legs pale with 1/3 of fore tibiae and tarsi fuscous; Cu of fore wing bordered with brown pigment; SIPH pale; Cauda and anal plate pale. *Morphology* (Table S48; Fig. S48). Body oval, 0.95-1.44mm; Head smooth with a flat median protrusion on frons, epicranial suture weakly developed, head dorsum without tubercles with 8 acuminate setae shorter than 0.01mm long; Antennae 6-segmented, 0.6-0.77 times as long as body length, Ant.III with 5-9 narrow elliptical secondary rhinaria in a row on the whole segment, bearing 3-4 short pointed setae, Ant.III-VI imbricated with inconspicuous pointed setae, Ant.IV without secondary rhinaria, Ant.VIb with a single inconspicuous seta, PT 0.83-1.1 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.07-0.09mm long with 4-6 accessory setae, 1.0-1.14 times as long as 2HT; Thorax smooth without tubercles; Fore coxae slightly enlarged, longest setae on HTB 1.5 times as long as middle width of HTB, first tarsal segment with 8 chaetotaxy, 2HT 0.07-0.09mm long; Rs weakly developed; Dorsal abdominal setae sometimes on small elevations but conspicuous tubercles not developed, abdominal tergite VIII bearing a pair of short setae, abdominal margin I-IV with 0.01-0.02mm long of 2 setae on short cone-shaped tubercle; SIPH cylindrical, truncated, 0.04-0.06mm long; Cauda knobbed, 0.07-0.09mm with 9-13 setae; Anal plate bilobed, each lobe with 7-10 setae.

Types. Holotype. 1 alate viviparous female, Byeongnae-ri, Pyeongchang-gun, GW, South Korea, 15.viii.2013, Coll 130815YR-11, on *Corylus* sp., Y. Lee, CALS SNU; Paratypes. 14 alate viviparous females, same data as holotype; 4 alate viviparous females, Mt. Baegunsan, Gwangyang-si, JN, South Korea, 25.vii.2013, Coll 130725YR-21, on *Corylus* sp., Y. Lee, CALS SNU; 2 alate viviparous females, Sangdong-eub, Yeongwol-gun, GW, South Korea, 23.vi.2014, Coll 140612YR-23, on *Corylus* sp., Y. Lee, CALS SNU; 1 alate viviparous female, Is. Geojedo, GN, South Korea, 14.vii.2014, Coll 140714YR-7, on *Corylus* sp., Y. Lee, H. Lee and J. Jung, CALS SNU.

Host plant. Corylus spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, China, Japan and Eastern Siberia.

Remarks. This species seems to prefer to feed on C. *sieboldiana*.

Etymology. The species name occultus is derived from Latin adjective, ‘occultus’ (hidden).

Genus *Monelliopsis* Richards, 1965 무늬호두알락진딧물속 (신칭)

Type species: *Callipterus caryae* Monell, 1879: 29, 31.

= *Monelliopsis caryae* (Matsumura, 1917).

Diagnosis. This genus is morphologically similar to *Monellia* Oestlund but can be recognized by having marginal tubercle on abdominal margin I-V (*Monellia* spp. marginal tubercle only developed on abdominal mergin I-III).

Host plant. Juglans spp.* (Juglandaceae).

Distribution. Palearctic, introduced into Nearctic region.

Remarks. This genus is elected by Richards based on *M. caryae* in North America. This genus encompasses 10 species which are distributed in North and South America. Recently some species introduced into Europe, Middle East and South Africa. All species are associated with *Juglandaceae.*

Monelliopsis caryae **(Monell, 1879) 무늬호두알락진딧물 (신칭)**

Callipterus caryae Monell, 1879: 29, 31; Thomas, 1879: 199; Oestlund, 1886: 51; Davidson, 1909: 301.

Monellia caryae Gillette, 1910: 367; Baker, 1917: 424; Oestlund, 1923: 135; Hottes and Frison, 1931: 251; Eastop and Hille Ris Lambers, 1976: 121, 286.

Monelliopsis caryae Richards, 1965: 90; 1966, 801; Blackman, 1980: 9; Remaudière and Remaudière, 1997: 219; Quednau, 2000: 150; Quednau, 2003: 29.

Diagnosis. This species is morphologically close to *M. tuberculate* Richards but can be distinguished by having no tubercles on thorax and abdominal dorsum I-III.

Description. Alate viviparous female. Color in iife. Head pale yellow with dark stripe markings, distal margin of antennal tubercle fuscous; Antenna pale, distal joint of Ant.II-VIb dark; Thorax pale yellow with dark margin; Abdomen pale with blackish dorsal and marginal tubercles on abdominal tergites I-II and IV-VII; Legs pale, fore and hind femur with black markig; Cu of fore wing, bordered with black pigment; SIPH pale; Cauda and anal plate slightly pigmented. *Morphology* (Table S49; Fig. S49). Body oval, 1.72-1.90mm long; Head smooth with a flat median protrusion on frons, epicranial suture weakly developed, head vertax with 0.02-0.03mm pointed setae, head dorsum without tubercles, antennal tubercle poorly developed; Antennae 6-segmented, 0.65-

0.72 times as long as body length, Ant.III with 7-12 transversely elliptical secondary rhinaria in a row on 1/2 of the segment, Ant.III-VI imbricated with inconspicuous hair like setae, Ant.IV without secondary rhinaria, Ant.VIb with a single seta, PT 1.00-1.25 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.09-0.10mm long with 5-7 accessory setae, 0.80-0.09 times as long as 2HT; Thorax smooth, without tubercles; Fore coxae enlarged, longest setae on HTB 0.67-1.00 times as long as middle width of HTB, first segment of hind tarsi with 6 chaetotaxy, 2HT 0.08-0.09mm long; Dorsal abdominal setae on small elevations but conspicuous tubercles not developed; Abdominal marginal tergite I-V with short cone-shaped tubercles, abdominal tergite VIII with a pair of spinal setae, abdominal margin I-V with a single acuminate seta on marginal tubercle; SIPH very short 0.01mm long; Cauda knobbed, 0.09-0.11mm long, bearing 7-9 setae; Anal plate bilobed, each lobe with 6-9 setae.

Materials examined. 20 alate viviparous females, Seodun-dong, Suwon-si, GG, South Korea, 15.vi.2001, Coll 010615SH-1, on *Juglans mandshurica*, S. Lee, NAAS.

Host plant. Juglans spp.* (Juglandaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, Europe and North America.

Remarks. This species is new to Korea.

Genus *Neochromaphis* Takahashi, 1921 날개알락진딧물

Type species: *Chromaphis carpinicola* Takahashi, 1921: 24.

= *Neochromaphis carpinicola* (Takahashi, 1921).

Foeniaphis Zhang & Qiao, 1998: 368.

Diagnosis. This genus is morphologically similar to *Pterocallis* Passerini but can be distinguished by having dense setae on body parts, very short length of PT and extensive brown pigmentation on fore wing.

Host plant. Carpinus spp.* (Betulaceae).

Distribution. Palearctic region.

Remarks. This genus is small genus comprising only 2 species in the world. All species are recognized in East Asia and associated with Betulaceae. Both species are ant attendece. Apterous viviparous female unknown.

Key to the species of *Neochromaphis* Takahashi in Korea

1. Ant.III with 3-5 rounded secondary rhinaria in a row on 2/3 of the segment ...
....***N. carpinicola***

- Ant.III with 10-15 rounded secondary rhinaria distributed in a whole surface...
....***N. coryli***

***Neochromaphis carpinicola* (Takahashi, 1921)** **날개알락진딧물**

Chromaphis carpinicola Takahashi, 1921: 24; 1923: 126; 1924: 110.

Neochromaphis carpinicola Takahashi, 1961: 13; Higuchi, 1972: 29; Remaudière, and Remaudière, 1997: 220; Quednau, 2003: 21.

Diagnosis. This species can be recognized from the only congeneric species

N. coryli Takahashi by having 3-5 rounded secondary rhinaria in a row on 2/3 of Ant.III, shorter length of URS with 3-5 accessory setae.

Description. Alate viviparous female. Color in iife. Head dark yellow, dark greenish yellow to brown, compound eye red; Antenna pale yellow, distal joint of Ant.III-VIb dark; Thorax and abdomen concolous with head, abdominal margin with dark pigmentation; Tibiae and tarsus pale, coxae and femur grayish; Fore wing with extensive brown pigmentation, wing vein with dark bordered margin; SIPH and cauda dark. *Morphology* (Table S50; Fig. S50). Body stout 1.26-1.72mm long; Head smooth with median protrusion on frons, head vertex convexed, head with 0.05-0.06mm long and pointed setae, epicranial suture weakly developed, antennal tubercle poorly developed, head dorsum without tubercle; Antenna 6-segmented, 0.52-0.66 times as long as body length, Ant.III with 3-5 round to transversely elliptical formed secondary rhinaria in a row on 2/3, longest setae on Ant.III same with BDAnt.III, Ant.I-II spiculose, Ant.IV-VI imbricated with about 0.01-0.02mm of hairlike setae, Ant.IV rarely with a secondary rhinaria, PT very short, 0.08-0.11 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.08-0.10mm long with 3-5 accessory setae, 0.89-1.13 times as long as 2HT; Thorax smooth, without tubercles; Fore coxae moderately enlarged, longest setae on HTB 1.00-1.33 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.07-0.10mm long; Dorsal abdomen hairy without conspicuous tubercles, abdominal tergite VIII with 4-6 setae, abdominal margin I-V with 2-6 long and fine setae on marginal tubercles; SIPH short 0.02-0.03mm long; Cauda knobbed, 0.09-0.14mm long, bearing 10-13 setae; Anal plate bilobed, each lobe with 7-9 setae.

Materials examined. 1 alate viviparous female, Is. Ulreungdo, GB, South Korea, 15.ix.1963, Coll 2568, on *Triticum aestivum*, W.H. Paik, NAAS; 1 alate viviparous female, Daegwanryeong-myeon, Pyeongchang-gun, GW, South Korea, 21-30.vii.1968, Coll 220, host plant unknown, W.H. Paik, NAAS; 7 alate viviparous females, Mt. Manisan, Is. Ganghwado, Incheon-si, GG, South Korea, 21.iv.2014, Coll 140421YR-4, on *Carpinus* sp., Y. Lee & H. Lee, CALS SNU; 19 alate viviparous females, Mt. Geumsan, Namhae-gun, GN, South Korea, 14.vii.2014, Coll 140714YR-3, on *Carpinus* sp., Y. Lee, H. Lee and JK. Jung, CALS SNU.

Host plant. Carpinus spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle. On twigs and leaves. Often ant attended.

Distribution. Korea and Japan.

Neochromaphis coryli (Takahashi, 1961) 개암나무알락진딧물

Neochromaphis coryli Takahashi, 1961: 12; Higuchi, 1972: 29; Eastop and Hille Ris Lambers, 1976: 310; Remaudière and Remaudière. 1997: 220; Quednau, 2003: 21.

Foeniaphis oblongisensoria Qiao and Zhang, 1998: 368.

Diagnosis. This species can be identified from the only congeneric species *N. carpinicola* Takahashi by having 10-15 rounded secondary rhinaria scattered on a whole surface of Ant.III, longer length of URS with 9-11 accessory setae.

Description. Alate viviparous female. Color in iife. Head dark yellow to brown, compound eye red; Antenna pale yellow, distal joint of Ant.III-PT darken; Thorax concolous with head; Abdomen dark yellow, abdominal margin and dorsal elevation dark pigmented; Coxae and femur dark yellow, tibiae pale yellow, tarsus dark; Fore wing with extensive brown marking, wing vein with dark bordered margin, Pts with dark marking; SIPH and cauda slightly pigmented. *Morphology* (Table S51; Fig. S51). Body stout 1.70-2.12mm long; Head slightly wrinkled with a flat median protrusion on frons, head vertex slightly convexed, head with 0.08-0.09mm long and pointed setae, epicranial suture weakly developed, antennal tubercle poorly developed, head dorsum without tubercles; Antenna 6-segmented, 0.49-0.60 times as long as body length, Ant.III with 10-15 rounded secondary rhinaria scattered on a whole surface of the segment, longest setae on Ant.III 3.00-3.50 times as long as BDAnt.III, Ant.I-III spiculose, Ant.IV-VI imbricated with about 0.02-0.07mm long and hairlike setae, Ant.IV without secondary rhinaria, PT very short, 0.14-0.17 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.15-0.16mm long with 9-11 accessory setae, 1.15-1.50 times as long as 2HT; Thorax without tubercles; Fore coxae moderately enlarged, longest setae on HTB 1.50-2.00 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.14-0.15mm long; Dorsal abdomen hairy without conspicuous tubercles, abdominal tergite VIII with 4-7 setae, abdominal margin I-V with 2-3 long and fine setae on marginal tubercles; SIPH short cylindrical with distal flange, 0.03-0.06mm long; Cauda knobbed, 0.12-0.14mm long, bearing 10-13 setae; Anal plate bilobed, each lobe with 9-13 setae.

Materials examined. 1 alate viviparous female, Suwon-si, GG, South Korea, 29.x.1957, Coll 2743, on *Corylus* sp., W.H. Paik, NAAS; 1 alate viviparous female, Chuncheon-si, GW, South Korea, 8.ix.1963, Coll 2615, on *Corylus heterophylla*, W.H. Paik, NAAS; 3 alate viviparous females, Cheongju-si, CB, South Korea, 1-10.vi.1970, Coll 221, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Daegwanryeong-myeon, Pyeongchang-gun, GW, South Korea, 21-30.vi.1971, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Hongcheon-gun, GW, South Korea, 3.vi.1998, Coll M1AJ02733, yellow pan trap, JY. Choi, NAAS; 5 alate viviparous females, Changwon-ri, Nam-myeon, Yeongwol-gun, GW, South Korea, 24.vi.2003, Coll 030624SH-3, on *Corylus* sp., S. Lee, CALS SNU; 1 alate viviparous female, Changwon-ri, Nam-myeon, Yeongwol-gun, GW, South Korea, 12.vi.2014, Coll 140612YR-7, on *Corylus* sp., Y. Lee, CALS SNU.

Host plant. Corylus spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves and twigs.

Distribution. Korea, China and Japan.

Remarks. This species is relatively rare species in Korea.

Genus *Panaphis* Kirkaldy, 1904 호두털알락진딧물속 (신칭)

Type species: *Aphis juglandis* Goeze, 1778: 311.

Juglandifex Amyot, 1847: 481.

Callipterus Koch, 1855: 208.

Callaphis Walker, 1870: 2000.

Ptychodes Buckton, 1881: 39.

Callipterinola Strand, 1928: 47.

Diagnosis. This genus is similar to *Chromaphis* but can be recognized by having large body size, dense hair on body parts and SIPH with 3-6 setae.

Host plant. Juglans spp.* (Juglandaceae).

Distribution. Palearctic and Nearctic region.

Remarks. This genus comprises 4 species, typically distributed across Asia and Europe and later introduced into North America. All species are associated with *Juglans* spp. (Juglandaceae).

Panaphis juglandis **(Goeze, 1778)** **호두털알락진딧물**

Aphis juglandis Goeze, 1778: 311.

Lachnus juglandis Kaltenbach, 1843: 159.

Juglandifex juglandis Amyot, 1847: 481.

Callipterus juglandis Koch, 1855: 208; Walker, 1858: 296; Passerini, 1860: 33.

Callipterus iuglandis Macchiati, 1883: 263.

Callipterus juglanalis Narzikulov and Umarov, 1969: 221.

Pterocallis juglandis van der Goot. 1915: 324.

Ptychodes juglandis Buckton, 1881: 40.

Panaphis juglandis Oestlund. 1923: 135; Remaudière, 1959: 470; Chakrabarti, Ghosh and Chowdhuri, 1970: 449; Remaudière and Remaudière, 1997: 221; Quednau, 2003: 23.

Callaphis juglandis Börner, 1952: 60; Chakrabarti, Ghosh and Raychaudhuri, 1972: 388; Quednau, 1973: 223; Eastop and Hille Ris Lambers, 1976: 63, 120.

Diagnosis. This species is morphologically close to *P. nepalensis* but can be distinguished by having rounded cauda knob, URS shorter than 2HT (0.89-0.94 times as long as 2HT), wing veins of fore dark bordered.

Description. Alate viviparous female. Color in iife. Head dark yellow mottled brown, compound eye red; Antenna pale yellow, Ant.I and distal joint of Ant.III-PT dark; Thorax dark yellow with dark brown marking; Abdomen bright yellow with blackish transverse band in each dorsal tergite, marginal tubercles on abdominal tergite I-IV dark pigmented; Legs pale, distal 1/3 of hind femur, HTB brown, all tarsus black; Wing veins of fore wing dark bordered with marginal marking, Pts and Co dark; SIPH and basal part of cauda slightly pigmented. *Morphology* (Table S52; Fig. S52). Body large oval 3.28-3.44mm long; Head wrinkled with 0.12-0.14mm long of fine setae, epicranial suture developed, antennal tubercle developed, head dorsum without tubercles; Antenna 6-segmented, 0.44-0.46 times as long as body length, inner margin of Ant.I slightly bulging, Ant.III with 18-23 rounded secondary rhinaria irregulary scattered on a whole surface, Ant.III-V hairy, longest setae on Ant.III 0.11-0.13mm long, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, Ant.VIb with 0.01mm short seta, PT very short, 0.44-0.56 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.15-0.16mm long with 13-14 accessory setae, 0.89-0.94 times as long as 2HT; Thorax hairy without tubercles; Fore coxae poorly enlarged; Longest setae on HTB 2.71-3.00 times as long as middle width of HTB, first segment of hind tarsi with 8 chaetotaxy, 2HT 0.16-0.18mm long; Wing vein of fore wing dark bordered; Dorsal abdominal tergite with hairy dark transvers sclerites without conspicuous tubercles, abdominal tergite VIII with 8-9 setae, abdominal margin I-V with 7-12 long and fine setae on marginal tubercles; SIPH 0.11-0.12mm, cylindrical, dark sclerotized with 4-6 long setae; Cauda knobbed, 0.30-0.32mm long, bearing 45-50 setae; Anal plate bilobed, each lobe with 35-40 setae.

Materials examined. 2 alate viviparous females, Jeju-si, JJ, South Korea, 13.v.2003, Coll 030513SH-10, on *Juglans* sp., S. Lee, CALS SNU.

Host plant. Juglans spp.* (Juglandaceae).

Biology. Monoecius holocyclic lifecycle. On upperside of leaves. Often ant attended.

Distribution. Korea, central Asia, Pakistan, India, Europe, and western USA.

Remarks. This species is new to Korea. Until now, this species was only collected in Is. Jejudo. This species is one of the famous walnut pest in North America.

Genus *Psuedochromaphis* Zhang, 1982 시나무알락진딧물속

Type species: *Chromaphis coreana* Paik, 1965: 45.

Diagnosis. This genus is recognized by having conspicuous cone shaped median protrusion, head and thorax brown with white wax markings and fore wing with extensive unique dark markings.

Host plant. Ulmus spp.* (Ulmaceae).

Distribution. Palearctic region.

Remarks. This genus is monospecific genus which is only collected from Korea and China. This species infests on *Hemiptelea davidii* (Ulmaceae). Apterous viviparous female unknown.

***Pseudochromaphis coreana* (Paik, 1965) 시나무알락진딧물**

Chromaphis coreana Paik, 1965: 45.

Tinocallis coreanus Eastop and Hille Ris Lambers 1976, 145.

Pseudochromaphis coreanus Remaudière and Remaudière, 1997: 222; Quednau, 2003: 25.

Diagnosis. This species can be easily distinguished by having conspicuous median protrusion, head and thorax brown with white wax markings fore wing with extensive unique dark markings, SIPH with a single pointed seta and first tarsal chaetotaxy 5-6.

Description. Alate viviparous female. Color in iife. Head and thorax brown with unique pattern mottled white wax marking, compound eye red; Ant.I-II brownish, Ant.III-VIb pale with dark distal joint, PT dark; Abdomen bright yellow with distinct dark markings on abdominal dorsum, marginal tubercles on abdominal tergite I-V dark sclerotized; Legs pale, tip of tarsus black; Fore wing with unique dark markings; SIPH dark; Cauda pale. *Morphology* (Table S53; Fig. S53). Body oval 1.36-1.57mm long; Head slightly wrinkled with 0.01mm short setae, head vertax with a distinct median protrusion, epicranial suture weakly developed, antennal tubercle developed, head dorsum without tubercles; Antenna 6-segmented, 0.70-0.77 times as long as body length, antennal setae short, almost invisiable, inner margin of Ant.I slightly bulging, Ant.III with 2-9 transversely elliptical secondary rhinaria in a row on 4/5 of the segment, longest setae on Ant.III 0.50 times as long as BDAnt.III, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, PT shorter than Ant.VIb, 0.23-0.45 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.07-0.09mm long with 4-5 accessory setae, 0.89-1.14 times as long as 2HT; Thorax smooth without tubercles; Fore coxae enlarged, longest setae on HTB 0.67-1.00 times as long as middle width of HTB, first segment of hind tarsi with 5-6 chaetotaxy, 2HT 0.07-0.09mm long; Dorsal abdominal sclerites scattered with/without spinal setae, abdominal tergite VIII with a pair of spinal setae, rarely with 3 setae, abdominal margin I-V with a single marginal seta on sclerotized marginal tubercles; SIPH cylindrical 0.05-0.08mm long with distal flange bearing 1 pointed seta; Cauda knobbed 0.07-0.09mm long with 9-10 setae; Anal plate bilobed, each lobe with 5-7 setae.

Materials examined. 3 alate viviparous females, Suwon-si, South Korea, 8.v.1968, Coll 4473, on *Ulmus pumila*, W.H. Paik, NAAS; 3 alate viviparous females, Suwon-si, South Korea, 17.v.1968, Coll 4540, on *Ulmus pumila*, W.H. Paik, NAAS; 2 alate viviparous females, Jaecheon-si, CB, South Korea, 16.viii.1969, Coll 5525, host plant unknown, W.H. Paik, NAAS; 2 alate viviparous females, Saeoul, South Korea, 26.v.1971, Coll 6369, on *Ulmus* sp., W.H. Paik, NAAS; 76 alate viviparous females, Mt. Hwayasan, GG, South Korea, 2.v.2014, Coll 140502YR-21, on *Hemiptelea davidii*, Y. Lee, CALS SNU; 1 alate viviparous female, Mt. Hwayasan, GG, South Korea, 26.v.2014, Coll 140526YR-4, on *Hemiptelea davidii*, Y. Lee, CALS SNU; 11 alate viviparous female, Jusagol, Yeoungyang, GB, South Korea, 12.viii.2014, 140812YR-1, *Hemiptelea davidii*, Y. Lee, CALS SNU.

*Host plant. Hemiptelea davidii** (Ulmaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea and China.

Genus *Pterocallis* Passerini, 1860 난퇴잎개암알락진딧물속

Type species: *Aphis alni* Fabricius, 1781: 386.

= *Pterocallis alni* (De Geer, 1773).

Clethraphis Amyot, 1847: 480.

Diagnosis. This genus is morphologically similar to *Mesocallis* Matsumura but can be distinguished by having abdominal dorsum with unpaired spinal tubercle or with spinulate setae and abdominal margin I-IV bearing more than a pair of setae.

Host plant. Alnus spp.*, *Carpinus* spp., *Corylus* spp. and *Ostrya* spp. (Betulaceae).

Distribution. Nearctic, Neotropical, Australian, Oriental and Palearctic region.

Remarks. This genus is comprised with 14 species under 2 subgenera. Most species are associated with *Alnus* spp. (Betulaceae). Apterous viviparous females commonly occur in some species of subgenus *Pterocallis* which are mostly distributed in Nearctic regions. *Recticallis* Matsumura species are only collected from Asian countries.

Key to the subgenera of *Pterocallis* Passerini in Korea

1. Abdominal dorsum I-IV without conspicuous tubercle....................***Pterocallis***
2. Abdominal dorsum I-IV with conspicuous unpaired tubercle..........***Recticallis***

Subgenus *Ptetocallis* Matsumura, 1919 난퇴잎개암알락진딧물아속

Type species: *Aphis alni* Fabricius, 1781: 386.

= *Pterocallis alni* (De Geer, 1773).

Clethraphis Amyot, 1847: 480.

Diagnosis. This subgenus can be easily recognized from *Recticallis* by having no conspicuous tubercle on abdominal dorsum I-IV.

Host plant. Alnus spp.*, *Carpinus* spp.*, *Corylus* spp. and *Ostrya* spp. (Betulaceae).

Distribution. Nearctic, Oriental, Palearctic regions.

Remarks. This subgenus is included 11 species mostly distributed in North America. All species are associated with Betulaceae spp.

***Pterocallis* (*Pterocallis*) *hetrophylla* Quednau, 1979**

난티잎개암나무알락진딧물

Pterocallis heterophylla Quednau, 1979: 507; Remaudière and Remaudière, 1997: 222.

Pterocallis amurensis Pashtshenko, 1985: 222.

Pterocallis (*Pterocallis*) *heterophylla* Quednau, 2003: 18.

Diagnosis. This species is easily distinguished from other congeneric species by having relatively very short length of rostrum and spinulate setae on thorax and dorsal abdominal tergite.

Description. Alate viviparous female. Color in iife. Body color of entire body variable, pale yellow to bright yellow, bright orange and yellowish green, compound eye red; Antenna pale, Ant.III-PT with dark distal joint; Abdominal margin and dorsal elevations slightly pigmented; Legs pale, femur slightly pigmented; Pts and Co of fore wing dark; Tip of SIPH slightly dark; Cauda pale. *Morphology* (Table S54; Fig. S54). Body stout 1.27-1.44mm long; Head slightly wrinkled bearing 0.03-0.05mm setae, frons with a median protrusion, epicranial suture weakly developed, antennal tubercle developed, head dorsum without tubercles; Antenna 6-segmented, 0.79-0.88 times as long as body length, antennal setae short and pointed, Ant.III with 3-5 round secondary rhinaria in a row on 1/2 of the segment, longest setae on Ant.III 0.05-0.10 times as long as BDAnt.III, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, PT short, 0.54-0.67 times as long as Ant.VIb; Rostrum very short never reaching to middle coxae, URS 0.04-0.05mm long without accessory setae, 0.69-0.77 times as long as 2HT; Thorax smooth with spinulate setae, tubercle not developed; Fore coxae enlarged, longest setae on HTB almost same with middle width of HTB, first segment of hind tarsi with 6 chaetotaxy, 2HT 0.08-1.00mm long; Dorsal abdomen with spinulate spinal setae, spinal setae on tergite I-IV on a pair of small elevations, conspicuous dorsal tubercle not developed, abdominal tergite VIII with 5-8 spinal setae, abdominal margin I-IV with a pair of setae on marginal elevation; SIPH very short, 0.01-0.02mm long; Cauda knobbed 0.13-0.15mm long with 11-14 setae; Anal plate bilobed, each lobe with 6-8 setae.

Materials examined. 20 alate viviparous females, Mt. Manisan, Is. Ganghwado, Incheon-si, GG, South Korea, 21.vi.2014, 140621YR-2, *Carpinus* sp. Y. Lee & H. Lee, CALS SNU; 1 alate viviparous female, Is. Geojedo, GN, South Korea, 14.vii.2014, Coll 140714YR-5, on *Carpinus sp.*, Y. Lee, CALS SNU.

Host plant. Carpinus sp.* and *Corylus heterophylla** (Betulaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea.

Remarks. This species was firstly recorded by Quednau (1979) based on North Korean specimens. In the original description, this species was collected on *Corylus heterophylla*. However, in South Korea, large amount of specimens were only collected on *Carpinus* spp. Body color in life is highly variable such as pale yellow, bright orange and yellowish green.

Subgenus *Recticallis* Matsumura, 1919 외줄낙타진딧물아속

Type species: *Recticallis alnijaponicae* Matsumura, 1919: 106.

Diagnosis. This subgenus can be easily recognized by having PT almost same or longer than Ant.VIb and conspicuous unpaired tubercle on abdominal tergite I-IV.

Host plant. Alnus spp.* (Betulaceae).

Distribution. Oriental and Palearctic regions.

Remarks. 3 Asian species belong to this subgenus. All species are associated with *Alnus* spp. Apterous viviparous female not occur.

Key to the species of *Recticallis* Matsumura in Korea

1. Apex of fore wing without dark markings, longest spinal tubercle on abdominal tergite I-IV 0.05-0.08mm.. ***P. alnijaponicae***

\- Apex of fore wing with unique dark markings, longest spinal tubercle on abdominal tergite I-V 0.13-0.21mm .... ***P. nigrostriata***

***Pterocallis* (*Recticallis*) *alnijaponicae* Matsumura, 1919**

일본외줄낙타진딧물 (신칭)

Recticallis alnijaponicae Matsumura, 1919: 106; Takahashi, 1965: 57; Higuchi, 1972: 32; Quednau and Shaposhnikov, 1988: 1028; Remaudière and Remaudière, 1997: 223.

Agrioaphis moriokae Shinji, 1935: 282.

Tuberculoides alnifoliae Shinji, 1965: 364.

Pterocallis (*Recticallis*) *alnijaponicae* Eastop and Hille Ris Lambers, 1976: 368, 372; Pashtshenko, 1983: 27; Quednau, 2003: 19.

Diagnosis. This species is morphologically close to *P. nigrostriata* Shinji but can be easily distinguished by having longest tubercle on abdominal tergite I-IV 0.05-0.08mm and apex of fore wing without dark marking.

Description. Alate viviparous female. Color in iife. Head pale to bright yellow, compound eye red; Antenna pale, Ant.III-VIb with dark distal joint; Thorax concolous with head; Abdomen pale, margin and dorsal tubercles pigmented; Legs pale, femur and tip of tibiae slightly pigmented; Wing veins of fore wing slightly pigmented; SIPH and cauda pale. *Morphology* (Table S55; Fig. S55). Body oval 1.46-1.85mm long; Head slightly wrinkled with 0.01-0.03mm setae, frons with a median protrusion, epicranial suture weakly developed, antennal tubercle developed, head dorsum without tubercles; Antenna 6-segmented, 0.77-0.90 times as long as body length, inner margin of Ant.I slightly bulging, Ant.III with 4-7 rounded secondary rhinaria in a row on 1/2 of the segment, longest setae on Ant.III 0.33-0.50 times as long as BDAnt.III, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, Ant.VIb with a 0.01mm of single seta, PT 0.62-1.00d times as long as Ant.VIb; Rostrum short not reaching to middle coxae, URS 0.07-0.08mm long with 4 accessory setae, 0.78-1.00 times as long as 2HT; Pronotum with a spinal elevation, meso- and metanotum smooth without tubercles; Fore coxae moderatly enlarged, longest setae on HTB 0.67-1.00 times as long as middle width of HTB, first segment of hind tarsi with 6-7 chaetotaxy, 2HT 0.08-0.09mm long; Center of dorsal abdominal tergite I-IV with a slightly pigmented fingerlike tubercle, abdominal tergite VIII with 6-7 setae, abdominal margin I-IV with a pair of setae on elevation, abdominal margin III-IV sclerotized; SIPH cylindrical 0.04-0.06mm long with distal flange; Cauda knobbed 0.09-0.12mm long with 10-12 setae; Anal plate bilobed, each lobe with 7-9 setae.

Materials examined. 3 alate viviparous females, Suwon-si, GG, South Korea, 8.v.1968, Coll 4465, on *Alnus* sp., W.H. Paik, NAAS; 2 alate viviparous females, Suwon-si, GG, South Korea, 10.v.1968, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Seoul, South Korea, 15-20.vi.1968, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 2 alate viviparous females, Seoul, South Korea, 21-30.vi.1968, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Suwon-si, South Korea, 8.xi.1971, Coll 6938, on *Alnus* sp., W.H. Paik, NAAS; 1 alate viviparous female, SNU, Gwanak-gu, Seoul, South Korea, 25.v.2004, Coll 040525HJ-4, on *Alnus* sp., H. Kim, CALS SNU; 7 alate viviparous females, Eawha wonmans Univ., Seodaemun-gu, Seoul, South Korea, 19.xi.2011, 111119YR-1, *Alnus* sp. Y. Lee, CALS SNU; 11 alate viviparous female, SNU, Gwanak-gu, Seoul, South Korea, 18.vii.2013, 130718YR-1, on *Alnus hirsute*, Y. Lee, CALS SNU; 13 alate viviparous females, Cheolgapryeong, Myeongju-gun, GW, South Korea, 14.viii.2013, 130814YR-6, on *Alnus* sp., Y. Lee, CALS SNU; 10 alate viviparous females, Ungyebong, Gangreung-si, GW, South Kroea, 29.viii.2013, 130829YR-10, on *Alnus* sp., Y. Lee, CALS SNU; 2 alate viviparous females, SNU, Gwanak-gu, Seoul, South Korea, 8.v.2014, 140508YR-1, on *Alnus hirsute*, Y. Lee, CALS SNU; 13 alate viviparous females, SNU, Gwanak-gu, Seoul, South Korea, 11.v.2014, 140511YR-1, on *Alnus hirsute*, Y. Lee, CALS SNU; 1 alate viviparous female, Yongdaeri, Inje-gun, GW, South Korea, 4.vi.2014, 140604YR-44, on *Alnus hirsute*, Y. Lee, CALS SNU.

Host plant. *Alnus* spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, China and Japan.

Remarks. This species is relatively very common species in Korea.

***Pterocallis* (*Recticallis*) *nigrostriata* (Shinji, 1941)** 외줄낙타진딧물

Tuberculoides nigrostriata Shinji, 1941: 383;

Recticallis nigrostriata Takahashi, 1965: 57; Quednau. 1997: 223.

Pterocallis (*Recticallis*) *nigrostriata* Eastop and Hille Ris Lambers, 1976: 368; Quednau, 1979: 509; Pashtshenko, 1983: 28; Quednau, 2003: 19.

Diagnosis. This species can be easily distinguished from *P. alnijaponicae* by having longest tubercle on abdominal tergite I-VI 0.13-0.21mm and apex of fore wing with unique marginal patches.

Description. Alate viviparous female. Color in iife. Head grayish yellow to dirty yellow, compound eye pale red; Antenna pale, Ant.I-VIb with dark distal joint; Thorax concolous with head; Abdomen pale, abdominal margin with dark brownish sclerites and dorsal tubercles slightly pigmented; Legs pale, middle and hind femur grayish pigmented; Fore wing with unique dark marking; SIPH and cauda pale. *Morphology* (Table S56; Fig. S56). Body oval 1.52-1.81mm long;

Head slightly wrinkled bearing 0.01-0.04mm setae, frons with a median protrusion, epicranial suture inconspicuously developed, antennal tubercle developed, head dorsum without tubercles; Antenna 6-segmented, 0.86-0.96 times as long as body length, inner margin of Ant.I slightly bulging, Ant.III with 3-4 rounded secondary rhinaria in a row on 1/2 of the segment, longest setae on Ant.III 0.50 times as long as BDAnt.III, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, PT 0.69-0.88 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.09mm long with 4-5 accessory setae, 0.82-1.00 times as long as 2HT; Pronotum with a spinal elevation, meso- and metanotum smooth without tubercles; Fore coxae moderatly enlarged, longest setae on HTB 0.63-0.74 times as long as middle width of HTB, first segment of hind tarsi with 6-7 chaetotaxy, 2HT 0.09-0.11mm long; Center of dorsal abdominal tergite I-VI with a slightly pigmented fingerlike tubercle, abdominal tergite VIII with 5-7 setae, abdominal margin I-IV with a pair of setae on elevation, abdominal margin III-IV sclerotized; SIPH cylindrical 0.06-0.10mm long with distal flange; Cauda knobbed 0.12-0.15mm long with 8-14 setae; Anal plate bilobed, each lobe with 7-12 setae.

Materials examined. 1 alate viviparous female, Pohang-si, GB, South Korea, 12.ix.1963, Coll 2488, on *Styrax japonicus*, W.H. Paik, NAAS; 1 alate viviparous female, Gimje-si, JB, South Korea, 21.ix.1963, Coll 2893, on *Alnus japonicus*, W.H. Paik, NAAS; 2 alate viviparous females, Namyang-myeon, CN, South Korea, 20.vi.1965, Coll 3798, on *Alnus japonica*, W.H. Paik, NAAS; 1 alate viviparous female, namyang-myeon, CN, South Korea, 26.ix.1968, Coll 4865, on *Alnus japonica*, W.H. Paik, NAAS; 3 alate viviparous females, Seoul, South

Korea, 3.xi.1971, Coll 6900, on *Alnus sibirica*, W.H. Paik, NAAS; 12 alate viviparous females, Namhea-gun, GN, South Korea, 14.vii.2014, 140714YR-13, on *Alnus firma*. Y. Lee & H. Lee, CALS SNU; 1 alate viviparous female, Mt. Hallasan, JJ, South Korea, 1.viii.2014, 140801YR-9, on *Alnus firma*, Y. Lee, CALS SNU.

Host plant. Alnus spp.* (Betulaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea and Japan.

Remarks. In Korea, this species is only collected from southern part.

Genus *Sarucallis* Shinji, 1922 배롱나무알락진딧물속

Type species: *Sarucallis lythrae* Shinji, 1922: 730.

= *Sarucallis kahawaluokalani* (Kirkaldy, 1907)

Neotherioaphis Behura & Dash, 1975: 211.

Diagnosis. This genus is morphologically similar to *Tinocallis* Matsumura but can be recognized by having pronotum without spinal tubercles, fore wing with extensive dark markings.

Host plant. Lagerstroemia spp.* and *Lawsonia alba* (Lythraceae).

Distribution. Oriental and Palearctic region, introduced into Afrotropical, Nearctic, Neotropical.

Remarks. This is monospecific genus originally distributed in Asia. Recently this species has been introduced into Africa, Europe, North and South America.

Remaudière & Remaudière (1997) considered this genus as a synonym of *Tinocallis* based on its morphological similarities. However, Quednau (2003) revived this genus as a distinct genus.

Sarucallis kahawaluokalani **(Kirkaldy, 1907)** **배롱나무알락진딧물**

Myzocallis kahawaluokalani Kirkaldy, 1907: 43; Fullaway, 1910: 43; Shinji, 1949: 55; Basu, 1961: 390.

Callipterus kohawaluokalani Takahashi, 1921: 74; 1923: 44, 125.

Sarucallis lythrae Shinji, 1922: 730.

Sarucallis kahawaluokalani Tao, 1964: 225; Eastop and Hille Ris Lambers, 1976: 291, 386; Blackman, 1980: 9; Quednau, 2003: 46.

Sarucallis lagerstroemiae Tao, 1964: 225.

Tinocallis kahawaluokalani Richards, 1967: 540; Robinson, 1972: 606; Raychaudhuri, Ghosh and Das, 1980: 33; Agarwala and Mahapatra, 1986: 172.

Neotherioaphis chhenafuli Behura and Dash, 1975: 211.

Tinocallis (*Tinocallis*) *kahawaluokalani* Remaudière and Remaudière, 1997: 226; Quednau, 2001: 210.

Diagnosis. This species can be distinguished by having unique sclerotic body pattern, marginal tubercle only developed on abdominal tergite I-III and Co and Pts of fore wing with dark markings.

Description. Alate viviparous female. Color in iife. Head to thorax pale yellow, unique dark sclerotized, compound eye pale red; Ant.I-II brownish, Ant.III-VIb pale with dark distal joint; Abdomen pale yellow with sclerotized abdominal dorsal tubercles; Coxae and distal tip of femur brownish, tibiae and tarsus pale; marginal wing vein with dark markings, Co and Pts od fore wing with dark marking; SIPH dark; Cauda pale. *Morphology* (Table S57; Fig. S57). Body oval 1.13-1.42mm long; Head vertax with a pair of spinal setae on small tubercle, median protrusion on frons developed, epicranial suture developed, antennal tubercle weakly developed, head dorsum without tubercles; Antenna 6-segmented, 0.75-0.89 times as long as body length, Ant.III with 6-8 transversely elliptical secondary rhinaria in a row on 1/2 of the segment, longest setae on Ant.III 0.33-0.50 times as long as BDAnt.III, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, PT 0.79-1.09 times as long as Ant.VIb; Rostrum barely reaching to middle coxae, URS 0.07-0.08mm long with 3-5 accessory setae, 1.00-1.14 times as long as 2HT; Thorax smooth without tubercles; Fore coxae enlarged, longest setae on HTB 0.67-1.00 times as long as middle width of HTB, first segment of hind tarsi with 6 chaetotaxy, 2HT 0.07-0.10mm long; Dorsal abdominal tergite I-II with a pair of spinal setae on distinct sclerotized tubercle, 2nd dorsal tubercle broadrly fused basally, abdominal tergite VIII with a pair of spinal setae, abdominal margin I-III with a single seta on sclerotized tubercle; SIPH sclerotized cylindrical 0.03-0.05mm long with distal flange; Cauda knobbed 0.08-0.10mm long with 7-9 setae; Anal plate bilobed, each lobe with 6-8 setae.

Materials examined. 1 alate viviparous female, Suwon-si, South Korea, 1-10.ix.1968, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Daejeon-si, CN, South Korea, 21-30.vi.1969, Coll 300, yellow pan trap, W.H. Paik, NAAS; 6 alate viviparous females, Gimje-si, JN, South Korea, 11-20.ix.1971, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 8 alate viviparous females, Sindap-dong, Dongdaemun-gu, Seoul, South Korea, 11.vi.2011, Coll 110611YR-69, on *Lagerstroemia indica*, Y. Lee, CALS SNU; 26 alate viviparous females, Sindap-dong, Dongdaemun-gu, Seoul, South Korea, 14.vi.2012, Coll 120614YR-10, on *L. indica*, Y. Lee, CALS SNU; 6 alate viviparous females, Chusan research foreat, Gwangyang, JN, South Korea, 24.vii.2013, 130724YR-3, on *L. indica*, Y. Lee, CALS SNU; 19 alate viviparous females, Goheung firestation, Goheung, JN, South Korea, 28.vii.2013, 130728YR-30, on *L. indica*, Y. Lee, CALS SNU; 13 alate viviparous females, Byeollyang-myeon, Suncheon-si, JN, South Korea, 28.vii.2013, 130728YR-33, on *L. indica*, Y. Lee, CALS SNU; 18 alate viviparous females, Chodang-dong, Gangreung-si, GW, South Korea, 28.vii.2013, 130728YR-30, on on *L. indica*, Y. Lee, CALS SNU.

Host plant. Lagerstroemia spp.* and *Lawsonia alba* (Lythraceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Widely distributed in East and South-east Asia, introduced into Europe, North and South America.

Remarks. This species is one of the famous invasive pest infesting on *Lagerstroemia* spp.

Genus *Shivaphis* Das, 1918 팽나무알락진딧물속

Type species: *Shivaphis celti* Das, 1918: 246.

Diagnosis. This genus can be easily recognized by having well developed wax gland plates on dorso surface without tubercles and pit like SIPH.

Host plant. Celtis spp.* and *Proceltis* spp. (Celtidaceae).

Distribution. Nearctic, Neotropical, Oriental and Palearctic region.

Remarks. This genus encompasses 7 species of 2 subgenera in the world. Typically Palearctic origin and recently some species have been introduced into North and South America. All species are associated with *Celtis* spp. and *Proceltis* spp. Apterou viviparous female commonly occur in subgenus *Shivaphis*.

Key to the subgenera of *Shivaphis* Das in Korea

1. Abdominal tergite VIII without spinal elevation, wax gland plate developed around SIPH ....***Shivaphis***

- Abdominal tergite VIII with a single triangular spinal elevation, wax gland pore developed SIPH..***Sinishivaphis***

Subgenus *Shivaphis* Das, 1918 팽나무알락진딧물아속

Type species: *Shivaphis celti* Das, 1918: 246.

Diagnosis. This subgenus is easily recognized from *Sinishivaphis* Zhang & Zhong by abdominal tergite VIII without spinal elevation and wax gland pore not developed on surface of SIPH.

Host plant. Celtis spp.* (Celtidaceae).

Distribution. Nearctic, Neotropical, Oriental and Palearctic regions.

Remarks. This subgenus comprises 3 species which are widely distributed across south-east Asia and Eastern Europe. All species are associated with *Celtis* spp. (Celtidaceae).

Key to the species of *Shivaphis* Das in Korea

1. Secondary rhinaria on Ant.III distributed on over whole part, URS with 5-7 accessory setae ....***S.* (*Sh.*) *catalpinari***

- Secondary rhinaria on Ant.III never distributed on over whole part, URS with 7-8 accessory setae **2**

2. Ant.III 0.45-0.75mm long with 7-10 transversely elliptical secondary rhinaria ....***S.* (*Sh.*) *celti***

- Ant.III 0.76-0.89mm long with 16-18 narrow transversely elliptical secondary rhinaria, ... ***S.* (*Sh.*) *sinensis* sp. nov.**

***Shivaphis* (*Shivaphis*) *catalpinari* Quednau & Remaudière, 1985**

풍게나무알락진딧물 (신칭)

Shivaphis catalpinari Quednau and Remaudière, 1985: 227, 231.

Shivaphis similicelti Zhang and Zhang, 1994: 20.

Shivaphis (*Shivaphis*) *catalpinari* Remaudière and Remaudière, 1997: 223; Quednau, 2003: 48.

Diagnosis. This species can be easily distinguished from *S.* (*Sh.*) *celti* by having secondary rhinaria on Ant.III distributed on over whole part, URS with

5-7 accessory setae and fore coxae weakly enlarged.

Description. Alate viviparous female. Color in iife. Not available. *Morphology* (Table S58; Fig. S58). Body oval 1.68-1.80mm long; Head vertax with a pair of wax gland plate, median protrusion on frons developed, epicranial suture not developed, antennal tubercle not developed, head dorsum with wax gland plates; Antenna 6-segmented, 0.73-0.76 times as long as body length, Ant.III with 21-23 transversely elliptical secondary rhinaria in a row on over whole surface, longest setae on Ant.III 0.50 times as long as BDAnt.III, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, Ant.VIb with a single seta, PT very short, 0.18 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.1mm long with 8-9 accessory setae, 0.77-0.83 times as long as 2HT; Thorax smooth with wax gland pore; Fore coxae weakly enlarged, longest setae on HTB 1.20-1.25 times as long as middle width of HTB, first segment of hind tarsi with 6 chaetotaxy, 2HT 0.12-0.13mm long; Dorsal abdominal tergite I-VIII with a pair of spinal setae on cribriformed wax gland plate, wax gland plate on abdominal tergite VIII fused, abdominal margin I-VII with a single marginal seta on wax gland plate; SIPH poriform with 0.03-0.04mm diameter; Cauda knobbed 0.10-0.12mm long with 9-10 setae; Anal plate bilobed, each lobe with 6-8 setae.

Materials examined. 2 alate viviparous females, unknown, South Korea, unknown, Coll 7303, host plant unknown, W.H. Paik, NAAS.

Host plant. Celtis spp.* (Celtidaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, China and Turkey.

Remarks. This species is relatively very rare species in Korea. Apterous viviparous female not observed.

***Shivaphis* (*Shivaphis*) *celti* Das, 1918 팽나무알락진딧물**

Shivaphis celti Das, 1918: 246; Takahashi, 1921: 74; Tao, 1964: 211; Higuchi, 1972: 34; Miyazaki, 1977: 203; Quednau, 1979: 514; Quednau and Remaudière, 1985: 231.

Chromaphis celticolens Essig and Kuwana, 1918: 95.

Shivaphis (Shivaphis) celti Remaudière and Remaudière, 1997: 223; Quednau, 2003: 47.

Diagnosis. This species can be easily distinguished from *S*. (*Sh*.) *catalpinari* by having secondary rhinaria on Ant.III distributed on middle part, URS with 8-10 accessory setae and fore coxae exremely enlarged.

Description. Apterous viviparous female. Color in iife. Head dirty yellow to greenish yellow, compound eye red; Ant.I-II concolorus with head, Ant.III-VIb pale with dark distal joint; thorax concolous with head or darker; Abdomen pale yellow to greenish yellow; Coxae and femur brownish, tibiae brighter than femur; SIPH dark; Cauda pale; Entire body covered with bluish white wax. *Morphology* (Table S59; Fig. S59). Body oval 2.40-2.85mm long; Head and thorax fused, head with wax gland plates dorso-ventrally, epicranial suture well developed, antennal tubercle weakly developed, head dorsum without tubercles; Antenna 6-segmented, 0.46-0.54 times as long as body length, Ant.III-IV without secondary rhinaria, longest setae on Ant.III 0.25-0.33 times as long as BDAnt.III, Ant.III-VI imbricated, Ant.VIb with a single seta, PT very short, 0.17-0.22 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.09-0.10mm long with 6-7 accessory setae, 0.67-0.71 times as long as 2HT; Fore coxae enlarged, longest setae on HTB 0.67-0.71 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.14-0.16mm long; Dorsal abdominal tergite I-VIII with a pair of spinal setae on wax gland plate, abdominal tergite VIII with a fused wax gland plate, abdominal margin I-VII with a single seta on sclerotized wax gland plate; SIPH very short, pit-like form; Cauda knobbed 0.13-0.17mm long with 7-8 setae, cauda knob elongated; Anal plate bilobed, each lobe with 8-12 setae.

Alate viviparous female. Color in iife. Head pale, dirty yellow to greenish yellow, compound eye red; Ant.I-II concolorus with head, Ant.III-VIb pale with dark distal joint; thorax brownish, darker than head; Abdomen pale yellow to greenish yellow; Coxae and distal harf of femur, HTB and tarsus brownish, fore and middle tibiae pale; Wing veins of fore wing dark bordered with pigmented markings; SIPH dark; Cauda pale; Entire body covered with bluish white wax. *Morphology* (Table S59; Fig. S59-2). Body oval 2.51-2.85mm long; Head with wax gland plates dorso-ventrally, epicranial suture well developed, antennal tubercle not developed, head dorsum without tubercles; Antennae 0.65-0.71 times as long as body length, Ant.III with 7-10 transversely elliptical secondary rhinaria on middle part of the segment, Ant.IV without secondary rhinaria, longest setae on Ant.III 0.20-0.33 times as long as BDAnt.III, Ant.IV-VI imbricated, Ant.VIb with a single seta, PT very short, 0.12-0.17 times as long as

Ant.VIb; Rostrum not reaching to middle coxae, URS 0.09-0.10mm long with 6-7 accessory setae, 0.64-0.71 times as long as 2HT; Fore coxae moderately enlarged, longest setae on HTB 0.67-1.17 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.14-0.16mm long; Dorsal abdominal tergite I-VIII with a pair of spinal setae on wax gland plate, dorsal spinal wax gland plate on tergite I, II and VIII fused, abdominal margin I-VII with a single seta on sclerotized wax gland plate; SIPH very short, pit-like form; Cauda knobbed 0.17-0.20mm long with 7-10 setae, cauda knob elongated finger shaped; Anal plate bilobed, each lobe with 12-16 setae.

Materials examined. 1 alate viviparous female, Seoguipo-si, JJ, South Korea, 16.viii.1957, Coll 0535, on *Celtis japonica*, W.H. Paik, NAAS; 1 alate viviparous female, Is. Anmyeondo, CN, South Korea, 19.viii.1963, Coll 1670, on *Artemisia capillaris*, W.H. Paik, NAAS; 1 alate viviparous female, Gwangju, JN, South Korea, 26.viii.1963, Coll 2361, on *Glycine max*, W.H. Paik, NAAS; 1 alate viviparous female, Seoguipo-si, JJ, South Korea, 5.vii.1965, Coll 3759, on *Celtis japonica*, W.H. Paik, NAAS; 2 alate viviparous females, Suwon-si, GG, South Korea, 19.iv.1968, Coll 4704, on *Celtis* sp., W.H. Paik, NAAS; 1 alate viviparous female, Seoul, South Korea, 21.v.1968, Coll 4585, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Seoul, South Korea, 11-15.vi.1968, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Suwon-si, GG, South Korea, 31.x.1971, Coll 6875, on *Celtis* sp., W.H. Paik, NAAS; 12 alate viviparous females, Wolpyeong-dong, Jeju-si, JJ, South Korea, 11.vi.1998, Coll 980611SH-1, *Celtis sinensis*, S. Lee, NAAS; 1 alate viviparous female, Wonseo-ri, Sanae-myeon, Milyang-si, GN, South Korea, 27.vi.2000, Coll

000627TM-51, host plant unknown, S. Lee, NAAS; 5 alate viviparous females, Mt. Songak, Daejeong, Jeju-si, JJ, South Korea, 13.v.2003, Coll 030513SH-61, host plant unknown, S. Lee, NAAS; 1 alate viviparous female, Jungmun catholic church, Seoguipo-si, JJ, South Korea, 27.v.2004, Coll 040527HJ-28, host plant unknown, H. Kim, CALS SNU; 9 alate viviparous females, Mt. Halla, Jeju-si, JJ, South Korea, 28.x.2009, Coll 091028SH-17, host plant unknown, S. Lee, CALS SNU; 5 apterous viviparous females and 1 alate viviparous female, Cheonripo-arboretum, Taean-gun, CN, South Korea, 10.v.2014, Coll 140510YR-14, on *Celtis* sp., Y. Lee & H. Lee, CALS SNU; 15 alate viviparous females, Mt. Cheonseong, Yeosu-si, JN, 5.vi.2014, Coll 140605YR-3, on *Celtis* sp. G. Cho, CALS SNU; 3 apterous viviparous females, Gwonseon-gu, Suwon-si, GG, South Korea, 30.vi.2014, Coll 140630YR-3, on *Celtis* sp., Y. Lee, CALS SNU; 6 apterous viviparous females and 4 alate viviparous females, Jangsan-forest, Goseong-gun, GN, South Korea, 3.v.2015, Coll 150503YR-17, on *Celtis* sp., Y. Lee & H. Lee, CALS SNU; 3 apterous viviparous females, Hampyeong, JN, South Korea, 5.v.2015, Coll 150505YR-18, on *Celtis* sp., Y. Lee & H. Lee, CALS SNU.

Host plant. Celtis spp.* (Celtidaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Widely distributed in Asia and Eastern Europe, introduced into North America.

Remarks. This species is one of the most common species in Korea. *S*. (*Sh*.) *celti* was introduced into South-eastern USA and widely spread in California.

***Shivaphis* (*Shivaphis*) *sinensis* Lee, sp. nov. 섬팽나무알락진딧물 (신칭)**

Diagnosis. This species is morphologically similar to *S*. (*Sh*.) *celti*. However, it can be distinguished by having longer length of Ant.III-V with 0.76-0.89mm, 0.43-0.48mm, 0.38-0.43mm long respectively and Ant.III with 16-18 narrow transversely elliptical secondary rhinaria.

Description. Alate viviparous female. Color in iife. Head dirty yellow, compound eye red; Ant.I-II concolorus with head, Ant.III-VIb pale with dark distal joint; thorax brownish; Abdomen pale yellow; Legs pale; Wing veins of fore wing with dark markings; SIPH and cauda pale; Entire body covered with bluish white wax. *Morphology* (Table S60; Fig. S60). Body oval 2.15-2.46mm long; Head with wax gland plates dorso-ventrally, epicranial suture weakly developed, antennal tubercle slightly developed, head dorsum without tubercles; Antenna 6-segmented, 0.94-1.01 times as long as body length, Ant.III with 16-18 narrow transversely elliptical secondary rhinaria in a row on basal 2/3 of the segment, Ant.IV without secondary rhinaria, longest setae on Ant.III 0.50 times as long as BDAnt.III, Ant.III-VI imbricated, Ant.VIb with a single seta, PT short, 0.14-0.18 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.09-0.10mm long with 7-8 accessory setae, 0.56-0.67 times as long as 2HT; Fore coxae moderately enlarged, longest setae on HTB 0.71-1.00 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.14-0.17mm long; Dorsal abdominal tergite I-II and VIII with wax gland plate, abdominal tergite VIII with a pair of pointed setae, abdominal margin I-VII with sclerotized wax gland plate bearing a single seta; SIPH very short and pit-like form; Cauda knobbed 0.13-0.16mm long with 8-10 setae, cauda knob globular shaped; Anal plate bilobed, each lobe with 16-17 setae.

Types. Holotype. 1 alate viviparous female, Bongnae waterfall, Jeodong-ri, Ulreung-eub, Is. Ulreungdo, GN, South Korea, 8.vi.2014, Coll 040608HJ-59, on *Celtis sinensis*, H. Kim, CALS SNU; Paratypes. 5 alate viviparous females, same data as holotype.

*Host plant. Celtis sinensis** (Celtidaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea.

Remarks. This species is newly recognized from Korea. Until now, this species was only collected from Is. Ulreungdo on *Celtis sinensis*.

Etymology. The species name *sinensis* is derived from host plant name *Celtis sinensis*.

Subgenus *Sinishivaphis* Zhang, 1982 혹팽알락진딧물아속

Type species: *Sinishivaphis hangzhouensis* Zhang & Zhong, 1982: 68.

Diagnosis. This subgenus can be distinguished by having longer length of antenna, distinct dark markings on fore wing and abdominal tergite VIII with triangular spinal elevation and wax gland pore developed on SIPH.

Host plant. Celtis spp.* and *Proceltis* spp. (Celtidaceae).

Distribution. Nearctic, Neotropical, Oriental and Palearctic regions.

Remarks. This subgenus includes 5 species originally distributed in Asia (Korea, China, Tadzhikistan, Uzbekistan, Kazakhstan, Pakistan and India) and recently introduced into North America. All species are associated with *Celtis* spp. and *Proceltis* spp. This subgenus was erected by Zhang (1982) as an independent genus. Later, Quednau and Remaudière (1985) considered this genus as a subgenus under *Shivaphis*. Apterous viviparous female not occur.

Key to the species of *Sinishivaphis* Zhang in Korea

1. Ant.III with 18-21 secondary rhinaria, PT 0.42-0.48 times as long as Ant.VIb ....***S*. (*Si*.) *szelegiewiczi***

- Ant.III with 7-11 secondary rhinaria, PT 0.35-0.43 times as long as Ant.VIb.... ....***S*. (*Si*.) *tilisucta***

***Shivaphis* (*Sinishivaphis*) *szelegiewiczi* Quednau, 1979 혹팽나무알락진딧물 (신칭)**

Shivaphis szelegiewiczi Quednau, 1979: 514.

Shivaphis (Shivaphis) szelegiewiczi Remaudière & Remaudière, 1997: 223.

Shivaphis (Sinishivaphis) szelegiewiczi Quednau, 2003: 48.

Diagnosis. This species can be easily distinguished from *S*. (*Si*.) *szelegiewiczi* by having Ant.III with 18-21 secondary rhinaria, PT 0.42-0.48 times as long as Ant.VIb.

Description. Alate viviparous female. Color in iife. Head pale to yellow, compound eye pale; Antenna pale, Ant.III-VIb pale with dark distal joint; thorax brownish; Abdomen pale yellow; Fore and middle legs pale, hind leg brownish; Wing veins of fore wing with pigmented markings; SIPH and cauda pale; Entire body covered with bluish white wax. *Morphology* (Table S61; Fig. S61). Body oval 2.31-2.85mm long; Head with wax gland plates dorso-ventrally, epicranial suture weakly developed, antennal tubercle slightly developed, head dorsum without tubercles; Antenna 6-segmented, long and slender, 1.16-1.42 times as long as body length, Ant.III with 18-21 transversely elliptical secondary rhinaria in a row on basal 2/3 of the segment, Ant.IV without secondary rhinaria, longest setae on Ant.III 0.50 times as long as BDAnt.III, Ant.III-VI imbricated, Ant.VIb mostly with a single seta, rarely with 2 setae, PT 0.42-0.48 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.12-0.13mm long with 12-15 accessory setae, 0.80-0.81 times as long as 2HT; Fore coxae enlarged, longest setae on HTB 0.71-1.14 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.14-0.16mm long; Dorsal abdominal tergite I-VIII with a pair of spinal setae, wax gland plate developed on abdominal tergite I-II, triangular spinal elevation developed on abdominal tergite VIII, abdominal margin I-VI with a single seta on sclerotized wax gland plate; SIPH short cylindrical, wax gland pore developed on surface of SIPH; Cauda knobbed 0.14-0.16mm long with 7-8 setae, cauda knob globular shaped; Anal plate bilobed, esch lobe with 8-9 setae.

Materials examined. 24 alate viviparous females, Jangneung Royal Tomb, Yeongwol-gun, GW, South Korea, 24.vi.2014, Coll 140624YR-4, on *Celtis* sp., Y. Lee, CALS SNU.

Host plant. *Celtis* spp.* (Celtidaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea and China.

Remarks. This species was firstly recorded by Quednau (1979) based on North Korean specimens. This is new to South Korea.

Shivaphis (_Sinishivaphis_) _tilisucta_ (Zhang, 1990) 짙은혹팽나무알락진딧물 (신칭)

Sinishivaphis tilisucta Zhang, 1990: 84.

Shivaphis (*Sinishivaphis*) *tilisucta* Remaudière and Remaudière, 1997: 223; Quednau, 2003: 48.

Diagnosis. This species can be easily recognized from *S*. (*Si*.) *tilisucta* Ant.III with 7-11 secondary rhinaria and PT 0.35-0.43 times as long as Ant.VIb.

Description. Alate viviparous female. Color in iife. Head pale green, compound eye red; Antenna pale, Ant.III-VIb pale with dark distal joint; thorax greenish brown; Abdomen pale green; Tibiae and tarsus pale, distal half of mid- and hind femur and basal half of HTB brownish; Wing veins of fore wing with pigmented markings; SIPH dark; Cauda pale; Entire body covered with bluish white wax. *Morphology* (Table S62; Fig. S62). Body oval 2.31-2.63mm long; Head with wax gland plates dorso-ventrally, epicranial suture weakly developed, antennal tubercle slightly developed, head dorsum without tubercles; Antenna 6-segmented, 0.85-0.92 times as long as body length, Ant.III with 7-11 transversely elliptical secondary rhinaria in a row on basal 2/3 of the segment, Ant.IV without secondary rhinaria, longest setae on Ant.III 0.67 times as long as BDAnt.III, Ant.III-VI imbricated, Ant.VIb with a single seta, PT 0.35-0.43 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.09-0.10mm long with 7-9 accessory setae, 0.69-0.77 times as long as 2HT; Fore coxae moderately enlarged, longest setae on HTB 1.00-1.33 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.13-0.14mm long; Dorsal abdominal tergite I-VIII with a pair of spinal setae, wax gland plate developed on abdominal tergite I-VII, wax gland plate on abdominal tergite I-III fused, triangular spinal elevation developed on abdominal tergite VIII, abdominal margin I-VII with a single seta on sclerotized wax gland plate; SIPH cylindrical 0.07-0.09mm long, wax gland pore developed on surface of SIPH; Cauda knobbed 0.12-0.14mm long with 7-8 setae, cauda knob globular shaped; Anal plate bilobed, each lobe with 9-12 setae.

Materials examined. 1 alate viviparous female, Seoul, South Korea, 3.xi.1970, Coll 6147, on *Celtis jessoensis*, W.H. Paik, NAAS; 1 alate viviparous female, Seoul, South Korea, 12.v.1971, Coll 6271, host plant unknown, W.H. Paik, NAAS; 1 alate viviparous female, Suwon-si, GG, South Korea, 18.v.1971, Coll 6305, on *Celtis japonica*, W.H. Paik, NAAS; 1 alate viviparous female, Suwon-si, GG, South Korea, 8.vi.1971, Coll 6396, on *Celtis japonica*, W.H. Paik, NAAS; 3 alate viviparous females, SNU-arboretum, Suwon-si, GG, South Korea, 30.iv.2014, Coll 140430YR2-2, Y. Lee, CALS SNU; 2 alate viviparous females, Mt. Cheonseongsan, Yeosu-si, Jeollanam-do, 5.vi.2014, Coll 140605YR-1, on *Celtis* sp., Y. Lee & H. Kim, CALS SNU; 1 apterous viviparous female and 3 alate viviparous females, Pagyero, Daegu, GB, South Korea, 2.v.2015, Coll 150502YR-4, on *Celtis* sp., Y. Lee & H. Kim, CALS SNU; 8 alate viviparous females, Jangsan-forest, Goseong, GN, South Korea, 3.v.2015, Coll 150503YR-16, on *Celtis choseniana*, Y. Lee & H. Kim, CALS SNU; 1 apterous viviparous female and 13 alate viviparous females, Hampyeong, JN, South Korea, 4.v.2015, Coll 150503YR-24, on *Celtis* sp., Y. Lee & H. Kim, CALS SNU; 1 apterous viviparous female and 7 alate viviparous females, Dangjin-gun, CN, South Korea, 3.vi.2015, Coll 150603YR-1, on *Celtis* sp., Y. Lee & H. Kim, CALS SNU.

Host plant. Celtis spp.* (Celtidaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea and China.

Remarks. This species is relatively common species in Korea.

Genus *Takecallis* Matsumura, 1917 조릿대알락진딧물속

Type species: *Takecallis bambusae* Matsumura, 1917: 354, 373.

= *Takecallis arundicolens* (Clarke, 1903).

Diagnosis. This genus is morphologically similar to *Subtakecallis* by having nose like processus on clypeus but differ in having longer length of PT compared with Ant.VIb.

Host plant. Arundinaria spp.*, *Bambusa* spp.*, *Dendrocalamus* spp., *Pseudosasa* spp., *Phyllostachys* spp.*, *Pleioblastus* spp. and *Sasa* spp.* (Poaceae).

Distribution. Afrotropical, Nearctic, Neotropical, Australian, Oriental and Palearctic region.

Remarks. This is small genus comprising 6 species in the world. *Typically* distributed in Palearctic region and recently some species introduced into Europe, Australia, New Zealand, North and South America. All species are associated various host plants belong to Poaceae. Apterous viviparous female unknown.

Key to the species of *Takecallis* Matsumura in Korea

1. Abdominal tergite VIII with 2-3 setae, rarely 4 setae......................***T. taiwana***

- Abdominal tergite VIII with 2 setae...**2**

2. Antenna 3.36-4.00mm, secondary rhinaria distributed on middle part of Ant.III ....***T. longiantennata* sp. nov.**

- Antenna 2.21-3.41mm, secondary rhinaria distributed on basal part of Ant.III **3**

3. Abdominal tergite I-VII with a pair of longitudinally elongated sclerotic elevations, SIPH with 0.03-0.06mm of single seta ....***T. arundinariae***

- Abdominal tergite I-VII with/without a pair of sclerotized elevations, SIPH with 0.02-0.03mm of single seta **4**

4. Cauda 0.14-0.15mm, SIPH 0.27-0.36 times as long as cauda.......................... ....***T. arundicolens***

- Cauda 0.12-0.13mm, SIPH 0.31-0.46 times as long as cauda ....***T. obscurus* sp. nov.**

***Takecallis arundicolens* (Clarke, 1903) 조릿대알락진딧물**

Callipterus arundicolens Clarke, 1903: 249; Davidson, 1909: 301; Mordvilko, 1921: 59.

Eucallipterus arundicolens Davidson, 1914: 127.

Myzocallis arundicolens Essig, 1917: 305; Baker, 1917: 423; Takahashi, 1923: 123.

Takecallis bambusae Matsumura, 1917: 354, 373.

Takecallis arundicolens Hille Ris Lambers, 1947: 658; Börner, 1952: 60; Tao, 1964: 220; Higuchi, 1968: 25; Higuchi, 1972: 35;Eastop and Hille Ris Lambers, 1976: 121; Quednau, 2003: 51.

Diagnosis. This species is superficially similar to *T. obscurus* **Lee, sp. nov.** but can be recognized by having longer length of cauda and SIPH 0.27-0.36 times as long as cauda.

Description. Alate viviparous female. Color in iife. Head pale to bright yellow, compound eye pale; Ant.I concolorous with head, Ant.II slightly dusky, basal 1/3 and distal 1/3 of Ant.III dark, basal half of Ant.IV-V and Ant.VIb dusky; Thorax concolous with head or darker; Abdomen pale yellow to bright yellow; Legs pale, tarsus dark; Wing vein dark, marginal wing vein bordered; SIPH pale; Cauda dark; Entire body slightly covered with white wax. *Morphology* (Table S63; Fig. S63). Body oval 1.57-1.89mm long; Head vertax with short and pointed hairs, median protrusion on frons developed, epicranial suture and antennal tubercle developed, head dorsum without tubercles; Antenna 6-segmented, 1.30-1.60 times as long as body length, Ant.III with 4-7 transversely elliptical secondary rhinaria in a row on 1/3 of the segment, longest setae on Ant.III 0.33

times as long as BDAnt.III, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, Ant.VIb with a single seta, PT 1.10-1.26 times as long as Ant.VIb; Clypeus with nose like processus, rostrum very short, reaching to fore coxae, URS short blunted, 0.05-0.06mm long with 4-5 accessory setae, 0.56-0.67 times as long as 2HT; Thorax smooth without tubercles; Fore coxae enlarged, longest setae on HTB almost same length with middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.09-0.10mm long; Pts of fore wing slightly dark; Dorsal abdominal tergite I-VII with a pair of spinal setae on small elevation, abdominal tergite VIII with a pair of spinal setae, andominal margin I-IV with a single seta on marginal tubercle; SIPH cylindrical, 0.04-0.05mm long, with 0.02-0.03mm of single seta; Cauda knobbed, 0.14-0.15mm long with 9-13 setae; Anal plate bilobed, each lobe with 7-8 setae.

Materials examined. 2 alate viviparous females, Naksan-temple, Ganghyeon-myeon, Yangyang-gun, GW, South Korea, 25.vi.2003, Coll 030625SH-62, on *Sasa sp.*, S. Lee, CALS SNU; 1 alate viviparous female, Namheae-gun, GN, South Korea, 7.iv.2006, Coll 060407SH-16, on *Sasa sp.*, S. Lee, CALS SNU; 1 alate viviparous female, Seobjikoji Beach, Seoguipo-si, JJ, South Korea, 27.iv.2006, Coll 060427SH-55, on *Sasa sp.*, S. Lee, CALS SNU; 3 alate viviparous females, Ehwa womans univ., Deahyeon-dong, Seodaemun-gu, Seoul, South Korea, 18.x.2011, Coll 111018YR-1, on *Arundinaria sp.*, Y. Lee, CALS SNU; 2 alate viviparous females, Taean-gun, CN, South Korea, 10.v.2014, Coll 140510YR-17, on *Sasa sp.*, Y. Lee & H. Lee, CALS SNU; 1 alate viviparous female, Is. Odongdo, Yeosu-si, JN, South Korea, 16.vii.2014, Coll 140716YR-1, on *Sasa* sp. (Poaceae), Y. Lee & H. Lee, CALS SNU.

Host plant. Arundinaria spp.*, *Bambus* spp.*, *Phyllostachys* spp.* and *Sasa* spp.* (Poaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, China, Japan, Eastern Russia and introduced into Europe and USA.

Remarks. This species is one of the common species in Korea. Recently introduced into Europe and USA. European and Asian populations morphologically variable.

***Takecallis arundinariae* (Essig, 1917) 대알락진딧물**

Myzocallis arundinariae Essig, 1917: 302; Takahashi, 1923: 62, 123.

Takecallis bambucifoliae Takahashi, 1921: 27.

Takecallis bambusifoliae Takahashi, 1921: 70, 73.

Takecallis arundinariae Börner, 1950: 60; Tao, 1964: 220; Hille Ris Lambers, 1965: 202; Takahashi, 1965: 58; Higuchi., 1972: 35; Eastop and Hille Ris Lambers, 1976: 290; Remaudière and Remaudière, 1997: 224; Quednau, 2003: 51.

Takecallis arundianariae Blackman, 1980: 9.

Diagnosis. This species can be easily distinguished from congeneric species by having a pair of longitudinally elongated sclerotic elevations on abdominal tergite I-VII with and SIPH with 0.03-0.06mm of single seta. *Description*. Alate viviparous female. Color in iife. Head pale to bright yellow with black stripe on head dorsum, compound eye pale red; Ant.I-basal half of Ant.III dark, distal joint of Ant.III-VIb dusky; Thorax pale yellow with dark stripe pattern; Abdomen pale yellow with pair of dark dorsal tubercle; Legs pale, tarsus dark; Wing vein dark, marginal wing vein bordered; SIPH and cauda pale; Entire body slightly covered with wax. *Morphology* (Table S64; Fig. S64). Body oval 1.90-2.65mm long; Head vertax with 0.01-0.02mm short and pointed hairs, median protrusion on frons developed, epicranial suture and antennal tubercle developed, head dorsum without tubercles; Antenna 6-segmented, 1.22-1.39 times as long as body length, Ant.III with 5-10 transversely elliptical secondary rhinaria in a row on 1/4 of the segment, longest setae on Ant.III 0.20-0.33 times as long as BDAnt.III, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, PT 0.94-1.27 times as long as Ant.VIb; Clypeus with nose like processus, rostrum very short, passing over fore coxae, URS short blunted, 0.05-0.06mm long with 4 accessory setae, 0.42-0.60 times as long as 2HT; Thorax smooth without tubercles; Fore coxae enlarged, longest setae on HTB 0.75-1.25 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.10-0.12mm long; Co and Pts of fore wing slightly dark; Dorsal abdominal tergite I-VII with a pair of spinal setae on small elevation, abdominal tergite VIII with a pair of spinal setae; SIPH cylindrical, 0.05-0.07mm long with 0.03-0.06mm long of single seta; Cauda knobbed 0.11-0.16mm long with 10-15 setae; Anal plate bilobed, each lobe with 8-12 setae.

Materials examined. 1 alate viviparous female, Seoul, South Korea, 15.v.1960, Coll 1258, on *Sinoarundinariae reticulata*, W.H. Paik, NAAS; 1 alate viviparous female, Seoul, South Korea, 3.xi.1971, Coll 6924, on *Sasa kurilensis*, W.H. Paik, NAAS; 5 alate viviparous females, Hwasun, JN, South Korea, 31.iii.1999, 990331SH-1, on unknown host, S. Lee, NAAS; 6 alate viviparous females, Chupungryeong, Gimcheon, GB, South Korea, 12.v.1999, Coll 990512SH-30, on *Sasa* sp., S. Lee, NAAS; 5 alate viviparous females, Sanjeri, Sanpomyeon, Naju, JN, South Korea, 12.i.2000, Coll 000112GM-04, on *Phyllostachys bambusoidea*, G.M. Kwon, NAAS; 5 alate viviparous females, Namyang-myeon, Goheung-gun, JN, South Korea, 14.iii.2000, Coll 000314SH-2, on *Phyllostachys bambusoidea*, S. Lee, NAAS; 3 alate viviparous females, Sanam-ri, Sacheon-gun, GN, South Korea, 16.iii.2000, Coll 000316SH-6, on *Phyllostachys bambusoidea*, S. Lee, NAAS; 4 alate viviparous females, Namhae-maeul, Namhae-gun, GN, South Korea, 8.iv.2006, 060408SH16, on *Gramineae* sp., S. Lee, CALS SNU; 2 alate viviparous females, Taean-gun, CN, South Korea, 10.v.2014, 140510YR-17, on *Phyllostachys* sp., Y. Lee & H. Lee, CALS SNU.

Host plant. Arundinaria spp.*, *Bambus* spp.*, *Phyllostachys* spp.* and *Sasa* spp.* (Poaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. India, China, Taiwan, Korea, Japan and introduced to England, Netherlands, Hungary, Madeira, Australia, New Zealand, North America and Argentina.

Remarks. This species is originally distributed in South-east Asia and recently introduced into Europe, Australia, New Zealand, North and South America. In Korea, this species is relatively uncommon.

***Takecallis longiantennata* Lee, sp. nov. 더듬이대알락진딧물 (신칭)**

Diagnosis. This species is easily distinguished by having long length of antenna and secondary rhinaria on Ant.III distributed on middle part.

Description. Alate viviparous female. Color in iife. Head pale to yellow, compound eye red; Antenna pale, marginal border of Ant.I-II dusky, marginal part of 1/3 and distal joint of Ant.III dark, distal joint of Ant.IV-VIb dusky; Thorax and Abdomen pale yellow to bright yellow; Legs pale, distal 2/5 of HFM with dark marking, tarsus dark; Wing vein dark, marginal wing vein dark bordered; SIPH pale; Cauda slightly dark; Entire body covered with white wax. *Morphology* (Table S65; Fig. S65). Body oval 2.08-2.51mm long; Head with 0.02-0.03mm short and pointed setae, median protrusion on frons developed, epicranial suture and antennal tubercle developed, head dorsum without tubercles; Antenna 6-segmented, 1.48-1.70 times as long as body length, Ant.III with 4-7 transversely elliptical secondary rhinaria in a row on 1/3 of the segment, longest setae on Ant.III 0.25-0.50 times as long as BDAnt.III, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, PT 0.89-1.11 times as long as Ant.VIb; Clypeus with nose like processus, rostrum very short, barely reaching to fore coxae, URS short blunted, 0.05mm long with 4 accessory setae, 0.45-0.50 times as long as 2HT; Thorax smooth without tubercles; Fore coxae enlarged; Longest setae on HTB 0.06-1.00 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.10-0.11mm long; Pts of fore wing dark, marginal wing vein dark bordered; Dorsal abdominal tergite I-VII with a pair of spinal setae on small elevations, abdominal tergite VIII with a pair of spinal setae, abdominal margin I-IV with a single seta on marginal tubercle; SIPH cylindrical

0.08-0.11mm long, bearing 0.03-0.05mm of single seta; Cauda knobbed 0.12-0.14mm long with 9-12 setae; Anal plate bilobed, each lobe with 7-10 setae.

Types. Holotype. 1 alate viviparous female, Mt. Hwangbyeong, Pyeongchang-gun, GW, South Korea, 29.viii.2013, Coll 130829YR-11, on *Sasa* sp., Y. Lee, CALS SNU; Paratypes. 10 alate viviparous females, same data as the holotype; 7 alate viviparous female, Mungyeong-eup, Mungyeong-si, GN, South Korea, 18.v.2005, Coll 050518SH-38, on *Sasa* sp., S. Lee, CALS SNU; 6 alate viviparous female, Mt. Hwangbyeong, Pyeongchang-gun, GW, South Korea, 15.viii.2013, Coll 130815YR-12, on *Sasa* sp., Y. Lee, CALS SNU; 5 alate viviparous female, Mt. Deokyousan, Muju-gun, JB, South Korea, 30.vi.2014, Coll 140630YR-2, on *Sasa* sp. (Poaceae), H. Lee, CALS SNU.

Host plant. Sasa sp.* (Poaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea.

Etymology. The species name *longiantennata* is derived from Latin suffix, longus and antenna referring to long antenna.

Remarks. This species is newly recognized in Korea.

Takecallis obscura Lee, sp. nov. 우리조릿대알락진딧물 (신칭)

Diagnosis. This species is considerably similar to *T. arundicolens* (Clarke) but can be recognized by having shorter length of cauda and SIPH 0.31-0.46 times as long as cauda.

Description. Alate viviparous female. Color in iife. Head pale to bright yellow, compound eye pale; Ant.I concolorous with head, Ant.II slightly dark, middle part and distal joint of Ant.III dark, distal joint of Ant.IV- VIb dusky; Thorax and Abdomen pale yellow to bright yellow; Legs pale, tarsus dark; Wing vein dark, marginal wing vein slightly bordered; SIPH pale; Cauda dark; Entire body slightly covered with wax. *Morphology* (Table S66; Fig. S66). Body oval 1.58-1.82mm long; Head with 0.01-0.03mm short and pointed hairs, median protrusion on frons developed, epicranial suture and antennal tubercle developed, head dorsum without tubercles; Antenna 6-segmented, 1.32-1.47 times as long as body length, Ant.III with 4-6 transversely elliptical secondary rhinaria in a row on 1/3 of the segment, longest setae on Ant.III 0.01mm long, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, PT 1.00-1.19 times as long as Ant.VIb; Clypeus with nose like processus, rostrum very short, reaching to fore coxae, URS short blunted, 0.05-0.07mm long with 4 accessory setae, 0.50-0.78 times as long as 2HT; Thorax smooth without tubercles; Fore coxae moderately enlarged, longest setae on HTB 1.00-1.33 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.09-0.10mm long; Co and Pts of fore wing pale; Dorsal abdominal tergite I-VII with a pair of spinal setae on small elevations, abdominal tergite VIII with a pair of setae; SIPH cylindrical, 0.04-0.06mm long with 0.02-0.03mm of single seta; Cauda knobbed 0.12-0.13mm long with 10-15 setae; Anal plate bilobed, each lobe with 7-8 setae.

Types. Holotype. 1 alate viviparous female, Mt. Hallasan, Seguipo-si, JJ, South Korea, 1.viii.2014, Coll 140801YR-7, on *Sasa* sp., Y. Lee, CALS SNU; Paratypes. 5 alate viviparous females, same data as the holotype; 5 alate viviparous female, Mt. Naejangsan, Jeongeup-si, JN, South Korea, 18.x.2013, Coll 131018JG-2, on *Sasa* sp., JG Jung, CALS SNU; 1 alate viviparous female, Donam-dong, Tongyeong-si, GN, South Korea, 11.v.2006, Coll 060511HJ-1, on *Sasa* sp., H. Kim, CALS SNU; 2 alate viviparous female, Ehwa womans univ., Deahyeon-dong, Seodaemun-gu, Seoul, South Korea, 18.x.2011, Coll 111018YR-1, on *Sasa* sp., Y. Lee, CALS SNU; 3 alate viviparous female, Yangjae-station, Seoul, South Korea, 5.v.2013, Coll 130505YR-1, on *Sasa* sp., Y. Lee & H. Lee, CALS SNU; 1 alate viviparous female, Cheonripo-arboretum, Taean-gun, CN, South Korea, 10.v.2014, Coll 140510YR-11, on *Sasa* sp., Y. Lee & H. Lee, CALS SNU; 1 alate viviparous female, Is. Odongdo, Yeosu-si, JN, South Korea, 16.vii.2014, Coll 140716YR-1, on *Sasa* sp., Y. Lee & H. Lee, CALS SNU.

Host plant. *Arundinaria* spp.*, *Bambus* spp.*, *Phyllostachys* spp.* and *Sasa* spp.* (Poaceae).

Biology. Monoecius holocyclic lifecycle. On upperside of leaves.

Distribution. Korea.

Etymology. The species name *obscura* is derived from Latin suffix, obscurua referring to imperceptible.

Takecallis taiwana (Takahashi, 1926) 대만조릿대알락진딧물 (신칭)

Myzocallis taiwanus Takahashi, 1926: 160.

Therioaphis tectae Tissot, 1932: 11.

Agrioaphis taiwanus Tseng and Tao, 1938: 209.

Takecallis sasae Tao, 1964: 220.

Takecallis taiwanus Stroyan, 1964: 33.

Takecallis taiwana Hille Ris Lambers, 1965: 202; Eastop, 1966: 520; Higuchi, 1968: 30; Higuchi, 1972: 36: Eastop and Hille Ris Lambers, 1976: 292; Remaudière and Remaudière. 1997: 224; Quednau, 2003: 50.

Diagnosis. This species is morphologically similar to *T. sasae* (Matsumura) but can be distinguished by having more than a pair of spinal setae on abdominal tergite I-VIII.

Description. Alate viviparous female. Color in iife. Not available. *Morphology* (Table S67; Fig. S67). Body oval 2.21-2.48mm long; Head with 0.04-0.05mm short and pointed setae, median protrusion on frons developed, epicranial suture and antennal tubercle developed, head dorsum dorsum with a central black stripe, spinal tubercle not developed; Antenna 6-segmented, 0.73-0.79 times as long as body length, Ant.III with 5-7 transversely elliptical secondary rhinaria in a row on basal 1/3 of the segment, longest setae on Ant.III 0.33-0.67 times as long as BDAnt.III, distal half of Ant.III-VI imbricated, Ant.IV without secondary rhinaria, PT 0.90-1.06 times as long as Ant.VIb; Clypeus with nose like processus, rostrum very short, reaching to fore coxae, URS short blunted, 0.07mm long with 4-5 accessory setae, 0.54-0.64 times as long as 2HT; Thorax smooth without tubercles; Fore coxae weakly enlarged; Longest setae on HTB 0.08-1.00 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.11-0.13mm long; Co and Pts of fore wing slightly dark;

Dorsal abdominal tergite I-VII with a pair of spinal setae on small elevations, abdominal tergite VIII with 2 setae; SIPH cylindrical, 0.04-0.06mm long; Cauda knobbed 0.15-0.20mm long with 12-13 setae; Anal plate bilobed, each lobe with 10 setae.

Materials examined. 6 alate viviparous females, Seoguipo-si, JJ, South Korea, 25.iv.1971, Coll 6196, on *Sasa* sp., W.H. Paik, NAAS; 8 alate viviparous females, Seoguipo-si, JJ, South Korea, 15.x.1971, Coll 6799, on *Sasa* sp., W.H. Paik, NAAS.

Host plant. *Arundinaria* spp.*, *Bambus* spp.*, *Phyllostachys* spp.* and *Sasa* spp.* (Poaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, China, Taiwan, Japan and introduced to Europe, South Africa, New Zealand, North and South America.

Remarks. This species was firstly recorded by Quednau & Lee (2001) based on Paik's specimens. Previously, this species was misidentified as *Takecallis sasae* (Matsumura, 1917) by Paik (1972).

Genus *Therioaphis* Walker, 1870 콩알락진딧물속 (신칭)

Type species: *Aphis ononidis* Kaltenbach, 1846: 173.

Diagnosis. This genus is recognized by having flabellate spinal setae on sclerotic patch developed on abdominal dorsum, Co and Pts of fore wing dark.

Host plant. Astragalus spp., *Dorycnium* spp., *Medicago* spp.*, *Melilotus* spp.*, *Lotus* spp., *Onobrychis* spp., *Ononis* spp., *Trifolium* spp.* (Fabaceae).

Distribution. Afrotropic, Nearctic, Neotropical, Australian, Oriental and Palearctic region.

Remarks. This is large genus comprising 25 species under 3 subgenera typically distributed across Europe and Asia. Some species have been introduced into Africa, Australia, New Zealand, North ans South America. All species are associated with various host plants belonging to Fabaceae. Apterous viviparous female commonly occur.

Subgenus *Pterocallidium* Börner, 1949 날개콩알락진딧물아속 (신칭)

Type species: *Chaitophorus maculata* Buckton, 1899: 277.

= *Therioaphis trifolii trifolii* (Monell, 1882).

Triphyllaphis Börner, 1949: 48.

Diagnosis. This subgenus can be recognized from other subgenera by having at least 5-6 spinal setae, rarely 4 setae developed on abdominal tergite I-V, 2nd abdominal margin with dark sclerotized.

Host plant. Astragalus spp., *Dorycnium* spp., *Medicago* spp.*, *Melilotus* spp.*, *Lotus* spp., *Onobrychis* spp., *Ononis* spp., *Trifolium* spp.* (Fabaceae).

Distribution. Afrotropic, Nearctic, Neotropical, Australian, Oriental, and Palearctic region.

Remarks. This is second largest subgenus comprising 8 species. Originallt distributed in Palearctic region but recently introduced into South Africa, Australia, New Zealand, North and South America. All species are associated with various host plants belonging to Fabaceae. Apterous viviparous female always occur.

Key to the species of subfamily *Pterocallidium* Börner in Korea

1. Abdominal tergite VIII with a pair of flabellate spinal setae on asymmetric sclerotic elevations..***T*. (*P*.) *subala***

- Abdominal tergite VIII with 4-5 flabellate spinal setae on asymmetric sclerotic elevations .... ***T*. (*P*.) *trifolii***

***Therioaphis* (*Pterocallidium*) *subalba* Börner, 1949 싸리날개콩알락진딧물 (신칭)**

Therioaphis subala Börner, 1949: 49; Börner, 1952: 63.

Triphyllaphis subalba Quednau, 1954: 35.

Therioaphis (*Therioaphis*) *subala* Hille Ris Lambers and van den Bosch, 1964: 34; Remaudière and Remaudière, 1997: 225.

Therioaphis (*Pterocallidium*) *subala* Quednau, 2003: 36.

Diagnosis. This species can be easily distinguished from *T*. (*P*.) *luteola* (Börner) by having only 2 spinal setae on dorsal tergite I-V.

Description. Alate viviparous female. Color in iife. Not available.

Morphology (Table S68; Fig. S68). Body oval 2.17mm long; Head with flabellate setae, median protrusion on frons developed, epicranial suture slightly developed, antennal tubercle developed, head dorsum without elevations; Antenna 6-segmented, longer than a body length, Ant.III with 16 small elliptical small sized secondary rhinaria in a row on basal 3/4 of the segment, longest setae on Ant.III 0.33 times as long as BDAnt.III, Ant.III-VI imbricated, Ant.IV without secondary rhinaria, PT longer than Ant.VIb; Rostrum short not reaching to middle coxae, URS 0.08mm long with 4 accessory setae, 0.62 times as long as 2HT; Thorax smooth without elevations; Fore coxae enlarged; Longest setae on HTB 0.75 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.13mm long; Dorsal abdominal tergite I-V with 4 flabellate spinal setae on sclerotized asymmetric elevations, some elevations fused, abdominal margin I-VII with a single seta on sclerotized asymmetric tubercle; SIPH cylindrical 0.05mm long; Cauda knobbed 0.22mm long with 12 setae, knob of cauda elongated egg shaped; Anal plate bilobed, each lobe with 7-9 setae.

Materials examined. 1 alate viviparous female, Namyang-myeon, CN, South Korea, 26.viii.1969, Coll 5316, on *Melilotus sauvelens*, W.H. Paik, NAAS.

Host plant. Lotus spp., *Medicago* spp., *Melilotus* spp.* and *Trifolium* spp. (Fabaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea and Europe.

Remarks. This species was firstly recorded by Quednau & Lee (2001) based on only 1 specimen of alate viviparous female. This specimen has Ant.V-VI and fore wings damages.

***Therioaphis* (*Pterocallidium*) *trifolii* (Monell, 1882) 콩알락진딧물 (신칭)**

Callipterus trifolii Monell, 1882: 14; Williams, 1891: 8; Davis, 1908: 256; Das, 1918: 244.

Chaitophorus maculatus Buckton, 1899: 277.

Callipterus genevei Sanborn, 1904: 38.

Myzocallis trifolii Gillette, 1910: 369; Baker, 1917: 423.

Therioaphis ononidis Baker, 1923: 281.

Pterocallidium lydiae Börner, 1949: 49.

Pterocallidium propinquum Börner, 1949: 49.

Therioaphis (Pterocallidium) trifolii Dickson, 1958: 68.

Pterocallidium trifolii Pintera, 1959: 72; Remaudière, 1959: 470.

Therioaphis trifolii Leonard, 1959: 15; Szelegiewicz, 1963: 59; Stroyan, 1964: 34; Eastop and Hille Ris Lambers, 1976: 122.

Therioaphis (*Therioaphis*) *trifolii* Hille Ris Lambers and van den Bosch. 1964: 36; Quednau, 2003: 35.

Therioaphis (*Therioaphis*) *trifolii brevipilosa* Hille Ris Lambers and van den Bosch, 1964: 10, 40.

Therioaphis cana Zhang, Chen, Qiao and Zhong, 1999: 234.

Therioaphis (*Pterocallidium*) *trifolii collina* Börner, 1952: 63.

Diagnosis. This species is similar to *T.* (*P.*) *khayami* Remaudière but can be distinguished by having 6-8 secondary rhinaria, cauda egg shaped, ventral abdominal sclerites absent.

Description. Apterous viviparous female. Color in iife. Head pale to bright yellow with dark elevations, compound eye red; Ant.I-II and Ant.V-VI dusky, distal margin of Ant.III-VI dusky; Thorax and abdomen pale to yellow with dark spots; Legs pale, tarsus dark; SIPH dark; Cauda pale. *Morphology* (Table S69; Fig. S69). Body oval 1.54-2.08mm long; Head with 0.03-0.05mm of apically flabellate setae on sclerotized elevations, median protrusion on frons developed, epicranial suture absent, antennal tubercle developed, head dorsum with sclerotized elevations; Antenna 6-segmented, 0.86-1.04 times as long as body length, Ant.III with 6-8 transversely elliptical small sized secondary rhinaria in a row on 2/3 of the segment, longest setae on Ant.III 0.33-0.50 times as long as BDAnt.III, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, PT 0.90-1.46 times as long as Ant.VIb; Rostrum barely reaching to middle coxae, URS 0.07-0.08mm long with 4-5 accessory setae, 0.67-0.80 times as long as 2HT; Thorax with apically flabellate setae on dorsal abdominal sclerites; Fore coxae enlarged, longest setae on HTB 0.50-1.00 times as long as middle width of HTB, first segment of hind tarsi with 6-7 chaetotaxy, 2HT 0.10-0.12mm long; Dorsal abdominal tergite I-VIII with 4-6 apically flabellate setae on sclerotized asymmetric elevations, some elevations fused, abdominal marginal tubercle sclerotized asymmetric shaped with a single flabellate seta; SIPH sclerotized cylindrical 0.04-0.07mm long; Cauda knobbed 0.16-0.20mm long with 11-17 setae, knob of cauda slightly elongated and angulated; Anal plate bilobed, each lobe with 7-9 setae.

Alate viviparous female. Color in iife. Head pale to yellow with dark transeverse band, compound eye red; Ant.I-II, distal joint of Ant.III, distal half of Ant.V and Ant.VI dusky; Thorax brownish; Abdomen pale to yellow with dark spots; Legs pale, tarsus dark; SIPH dark; Cauda pale; Wing vein of fore wing dark, Co and Pts dark, marginal wing vein dark bordered. *Morphology* (Table S69; Fig. S69-2). Body oval 1.94-2.19mm long; Head with 0.02mm of apically flabellate setae, median protrusion on frons developed, epicranial suture slightly developed, antennal tubercle developed, head dorsum with sclerotized elevations; Antenna 6-segmented, 0.94-0.95 times as long as body length, Ant.III with 6-8 transversely elliptical small sized secondary rhinaria in a row on basal 1/2 of the segment, longest setae on Ant.III 0.01mm long, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, PT 0.95-1.16 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.08-0.09mm long with 4-5 accessory setae, 0.67-0.75 times as long as 2HT; Thorax smooth without elevations; Fore coxae enlarged, longest setae on HTB 0.75-1.00 times as long as middle width of HTB, first segment of hind tarsi with 6-7 chaetotaxy, 2HT 0.12mm long; Dorsal abdominal tergite I-VIII with 3-7 apically flabellate setae on sclerotized asymmetric elevations, some elevations fused, abdominal margin I-VII with a single seta on sclerotized asymmetric tubercle; SIPH sclerotized cylindrical 0.04-0.07mm long; Cauda knobbed 0.17-0.19mm long with 13-15 setae, knob of cauda angulated; Anal plate bilobed, each lobe with 7-9 setae.

Materials examined. 5 apterous viviparous females and 2 alate viviparous females, Seonghwan-eub, Cheonan-si, CN, South Korea, 11.x.2000, Coll 001011GM-10, on *Medicago sativa*, G.M. Kwon, NAAS; 6 apterous viviparous females, SNU, Gwanak-gu, Seoul, South Korea, 27.viii.2014, Coll 140827YR-1, on *Trifolium repens*, Y. Lee & H. Lee, CALS SNU.

Host plant. Astragalus spp., *Lotus* spp., *Medicago* spp.*, *Melilotus* spp., *Onobrychis* spp., *Ononis* spp. and *Trifolium* spp.* (Fabaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, China, Japan, Kazakhstan, India, Pakistan, Middle East, Europe, introduced into North and South America, South Africa, and Australia.

Remarks. This species is one of the famous invasive species infesting on various leguminous plants.

Genus *Tiliaphis* Takahashi, 1961 피나무알락진딧물속

Type species: *Therioaphis shinae* Shinji, 1924: 346.

Diagnosis. This genus is morphologically similar to monospecific genus *Eucallipterus* Schouteden but can be recognized by having longer length of spinal setae on abdominal tergite, fore wing with dark zig-zag band on over distal part of media and cubital veins and SIPH long and pale without dark sclerites.

Host plant. Tilia spp.* (Tiliaceae).

Distribution. Palearctic region.

Remarks. This is small genus comprising 4 East Asian species which are associated *Tilia* spp. In Korea, all 4 species are distributed. Apterous viviparous female unknown.

Key to the species of *Tiliaphis* Takahashi in Korea

1. Abdominal dorsal tergites with dark sclerites, URS with 6 accessory setae .....
....***T. shinjii***

- Abdominal tergites pale without dark sclerotic patches, URS with 4-5 accessory setae **2**

2. Mesonotum with dark sclerites, Ant.III with 26-42 secondary rhinaria............
....***T. coreana***

- Mesonotum pale without sclerites, Ant.III with 8-17 secondary rhinaria.........**3**

3. Antenna 1.43-1.68mm long, Ant.III with 13-17 secondary rhinaria, URS 0.06-0.07mm ....***T. peudoshinae***

- Antenna 1.69-1.82mm long, Ant.III with 8-13 secondary rhinaria, URS 0.09-0.10mm ....***T. shinae***

***Tiliaphis coreana* Quednau, 1979 우리피나무알락진딧물**

Tiliaphis coreana Quednau, 1979: 511; Quednau and Shaposhnikov, 1988: 1030; Quednau, 2003: 30.

Tiliaphis mordvilkoi Pashtshenko, 1984: 491, 498.

Diagnosis. This species can be easily distinguished from congeneric species by having large body size, dark sclerites on mesonotum and Ant.III with 26-42 secondary rhinaria distributed on basal 2/3.

Description. Alate viviparous female. Color in iife. Head yellow with dark longitudinal band, compound eye red; Ant.I-III, distal half of Ant.IV-VIb dark, PT pale; Thorax yellow, marginal boder with dark longitudinal band; Abdomen bright yellow without dark spots; Legs pale; SIPH and cauda concolorus with body; Fore wing with dark zig-zag band on over distal part of media and cubital veins, Co and Pts dark. *Morphology* (Table S70; Fig. S70). Body oval 2.60-3.83mm long; Head with 0.06-0.09mm pointed setae on small elevations, median protrusion on frons developed, epicranial suture developed, antennal tubercle developed, head dorsum without tubercles; Antenna 6-segmented, 0.64-0.94 times as long as body length, antennal setae shor ans pointed, Ant.III with 26-42 transversely narrow elliptical secondary rhinaria irregulary distributed on basal 2/3 of the segment, longest setae on Ant.III 0.50-0.67 times as long as BDAnt.III, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, Ant.VIb with a short seta, PT 1.26-1.38 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.09-0.10mm long with 4-5 accessory setae, 0.77-0.91 times as long as 2HT; Thorax smooth without elevations; Fore coxae moderately enlarged, longest setae on HTB 0.83-1.00 times as long as middle width of HTB, first segment of hind tarsi with 8 chaetotaxy, 2HT 0.10-0.13mm long; Dorsal abdominal tergite I-VII with a pair of long ans pointed spinal setae on small elevations, abdominal tergite VIII with 2 spinal setae abdominal margin I-V with a single seta on elevations, 4th marginal tubercle large assymetric; SIPH cylindrical 0.08-0.11mm long with distal flange; Cauda knobbed 0.14-0.21mm long with 11-14 setae; Anal plate bilobed, each lobe with 11-16 setae.

Materials examined. 1 alate viviparous female, Seoul, South Korea, 17.ix.1963, Coll 2743, on Juglans manshurica, W.H. Paik, NAAS; 2 alate viviparous females, SNU Suwon Campers, Gwonseon-gu, Suwon-si, GG, South Korea, 17.vi.2003, Coll 030617HJ-2, on *Tilia* sp., H. Kim, CALS SNU; 25 alate viviparous females, Mt. Hwangbyeongsan, Byeongnaeri, Pyeongchang, GW, South Korea, 15.viii.2013, Coll 130815YR-9, *Tilia* sp., Y. Lee, CALS SNU; 3 alate viviparous females, Sangdong, Yeongwol, GW, South Korea, 12.vi.2014, Coll 140612YR-20, *Tilia* sp., Y. Lee, CALS SNU.

Host plant. Tilia spp.* (Tiliaceae).

Biology. Monoecius holocyclic lifecycle. On upperside of leaves in the nymphal stage. Often ant attended.

Distribution. Korea, China, Japan and Eastern Siberia.

Remarks. This species is largest species in this genus. According to Quednau (1979), North Korean specimen of this species show different morphological features.

***Tiliaphis pseudoshinae* Quednau, 1979 닮은참피나무알락진딧물 (신칭)**

Tiliaphis pseudoshinae Quednau, 1979: 509; Quednau and Shaposhnikov, 1988: 1030; Remaudière and Remaudière, 1997: 225; Quednau, 2003: 30.

Diagnosis. This species is morphologically very similar to *T. shinae* (Shinji) but differs in having shorter length of URS, shorter length of antenna and 13-17 secondary rhinaria on Ant.III.

Description. Alate viviparous female. Color in iife. Head pale to pale yellow with dark longitudinal band, compound eye red; Ant.I-II, basal half of Ant.III, distal joint of Ant.IV-VIb dark; Thorax pale yellow marginal boder with dark longitudinal band; Abdomen pale without dark spots; Legs pale; SIPH and cauda concolorus with body; Fore wing with dark zig-zag band on over distal part of media and cubital veins, Co and Pts dark. *Morphology* (Table S71; Fig. S71). Body oval 1.64-2.22mm long; Head with 0.03-0.04mm of pointed setae on small elevations, median protrusion on frons developed, epicranial suture developed, antennal tubercle developed, head dorsum with 0.06-0.07mm setae without tubercles; Antenna 6-segmented, 0.83-0.87 times as long as body length, Ant.III with 13-17 transversely elliptical secondary rhinaria in a row on basal 2/3 of the segment, antennal setae short and pointed, longest setae on Ant.III 0.33-0.50 times as long as BDAnt.III, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, PT 1.25-1.28 times as long as Ant.VIb; Rostrum short not reaching to middle coxae, URS 0.06-0.07mm long with 4 accessory setae, 0.06-0.78 times as long as 2HT; Thorax smooth without elevations; Fore coxae moderately enlarged, longest setae on HTB 0.75-1.00 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.09-0.10mm long; Dorsal abdominal tergite I-VIII with a pair of spinal setae on small elevations, abdominal margin I-V and VII with a single seta on elevations, 4th marginal tubercle large assymetric with spicules; abdominal margin VIII with a pair of marginal seta; SIPH cylindrical with distal flange 0.09-0.13mm long; Cauda knobbed 0.10-0.14mm long with 9-10 setae; Anal plate bilobed, each lobe with 7-8 setae.

Materials examined. 6 alate viviparous females, Northeast forestry University, Harbin-prov., China, 15.viii.2010, Coll 100815SH-1, *Tilia* sp., S. Lee, CALS SNU; 2 alate viviparous females, Taepyeong, Harbin-prov., China, 15.viii.2010, Coll 100815SH-61, *Tilia amurensis*, S. Lee, CALS SNU.

Host plant. Tilia spp.* (Tiliaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, China and Eastern Siberia.

Remarks. This species was firstly recorded by Quednau (1979) based on North Korean specimens. This species is morphologically very similar ro *T. shinae* and relatively very rare species.

***Tiliaphis shinae* (Shinji, 1924) 참피나무알락진딧물**

Therioaphis shinae Shinji, 1924: 346.

Tiliaphis japonica Higuchi, 1972: 37.

Tiliaphis shinae Takahashi, 1961: 251; Higuchi, 1972: 37; Quednau, 1979: 509; Remaudière and Remaudière, 1997: 226; Quednau, 2003: 30.

Diagnosis. This species is superficially similar to *T. pseudoshinae* Quednau but can be recognized by having longer length of URS and antenna and 8-13 secondary rhinaria on Ant.III.

Description. Alate viviparous female. Color in iife. Head pale to pale yellow with dark longitudinal band, compound eye red; Ant.I-II, basal half of Ant.III, distal joint of Ant.IV-VIb dark; Thorax pale yellow marginal boder with dark longitudinal band; Abdomen pale without dark spots; Legs pale; SIPH and cauda concolorus with body; Fore wing with dark zig-zag band on over distal part of media and cubital veins, Co and Pts dark. *Morphology* (Table S72; Fig. S72).

Body oval 1.62-1.83mm long; Head with 0.04-0.05mm setae on small elevations, median protrusion on frons developed, epicranial suture developed, antennal tubercle developed, head dorsum with 0.05-0.06mm setae, without tubercles; Antenna 6-segmented, 0.98-1.07 times as long as body length, Ant.III with 8-13 transversely elliptical secondary rhinaria irregulary distributed on basal 1/3 of the segment, antennal setae short and pointed, longest setae on Ant.III 0.50 times as long as BDAnt.III, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, Ant.VIb with 1 short seta, PT 1.12-1.43 times as long as Ant.VIb; Rostrum short not reaching to middle coxae, URS 0.09-0.10mm long with 4 accessory setae, 1.13-1.25 times as long as 2HT; Thorax smooth without elevations; Fore coxae moderately enlarged, longest setae on HTB 0.67-1.00 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.08-0.09mm long; Dorsal abdominal tergite I-VIII with a pair of spinal setae, abdominal margin I-V and VII with a single seta on small elevations, 4th abdominal marginal tubercle large assymetric with spicules; SIPH cylindrical with distal flange 0.09-0.11mm long; Cauda knobbed 0.10-0.11mm long with 8-10 setae; Anal plate bilobed, each lobe with 6-8 setae.

Materials examined. 2 alate viviparous females, Seoul, South Korea, 21.x.1971, Coll 6839, on *Tilia* sp., W.H. Paik, NAAS; 1 alate viviparous female, Daegwanryeong-myeon, Pyeongchang-gun, GW, South Korea, 21-30.vi.1978, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, SNU Suwon campers, Suwon, GG, South Korea, 5.vi.2003, Coll 030605HJ-3, on *Tilia* sp., H. Kim, CALS SNU; 7 alate viviparous females, Mulhyanggi-arboretum, Osan-si, GG, South Korea, 9.ix.2009, Coll 090911HR-10, on *Tilia* sp., H. Choi, CALS SNU; 4 alate viviparous females, Taepyeong, Harbin-prov., China, 15.viii.2010, Coll 100815SH-61, *Tilia* sp., H. Choi, CALS SNU; 15 alate viviparous females, Northeast forestry University, Harbin-prov., China, 15.viii.2010, Coll 100815HR-1, *Tilia* sp., H. Choi, CALS SNU; 7 alate viviparous females, Sangil, Harbin-prov., China, 15.viii.2010, Coll 100815HR-61, *Tilia* sp., H. Choi, CALS SNU.

Host plant. Tilia spp.* (Tiliaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, China, Japan and Eastern Siberia.

Tiliaphis shinjii **Higuchi, 1972 무늬피나무알락진딧물 (신칭)**

Tiliaphis shinjii Higuchi, 1972: 37, 38; Quednau and Shaposhnikov, 1988: 1030; Remaudière and Remaudière, 1997: 226; Quednau, 2003: 30.

Diagnosis. This species can be easily distinguished by having abdominal dorsal tergites with dark sclerites and URS with 6 accessory setae.

Description. Alate viviparous female. Color in iife. Head pale to yellow with dark longitudinal band, compound eye red; Ant.I-II, basal half of Ant.III, distal joint of Ant.IV-VIb and PT dark; Thorax yellow marginal boder with dark longitudinal band; Abdomen yellow with dark sclerites; Legs pale; SIPH and cauda concolorus with body; Fore wing with dark zig-zag band on over distal part of media and cubital veins, Co and Pts dark. *Morphology* (Table S73; Fig. S73). Body oval 1.58-2.04mm long; Head with 0.03-0.05mm setae on small elevations, median protrusion on frons developed, epicranial suture developed, antennal tubercle developed, head dorsum with 0.04-0.05mm setae, without tubercles; Antenna 6-segmented, 0.88-1.15 times as long as body length, Ant.III with 12-14 transversely elliptical secondary rhinaria in a row on basal 1/2 of the segment, antennal setae short pointed, longest setae on Ant.III 0.33 times as long as BDAnt.III, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, Ant.VIb with a single seta, PT 1.10-1.13 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.08-0.10mm long with 4-6 accessory setae, 0.82-1.00 times as long as 2HT; Thorax smooth without elevations; Fore coxae moderately enlarged; Longest setae on HTB same length with middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.09-0.11mm long; Dorsal abdominal tergite I-VIII with a pair of spinal setae on dark sclerotized elevations, abdominal margin with a single seta on elevations, 4th abdominal marginal tubercle slightly pigmented; SIPH cylindrical with distal flange 0.08-0.11mm long; Cauda knobbed 0.14-0.17mm long with 10-12 setae; Anal plate bilobed, each lobe with 6-9 setae.

Materials examined. 1 alate viviparous female, Seoul, South Korea, 11-15.vi.1968, Coll 298, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Seoul, South Korea, 15-20.vi.1968, Coll 298, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Seoul, South Korea, 21-30.vi.1968, Coll 297, yellow pan trap, W.H. Paik, NAAS; 27 alate viviparous females, SNU Suwon campers, Suwon, GG, South Korea, 17.vi.2003, Coll 030617HJ-2, on *Tilia* sp. (Tiliaceae), H. Kim, CALS SNU; 1 alate viviparous female, Mt. Baekdusan, YG, North Korea, 22.vi.2009, Coll 090622SH-41, on *Tilia* sp. (Tiliaceae), S. Lee et al., CALS SNU; 14 alate viviparous female, Chusan research forest, Gwangyang, JN, South Korea, 25.vii.2013, Coll 130725YR-12, on *Tilia* sp. (Tiliaceae), Y. Lee, CALS SNU; 6 alate viviparous females, Mt. Manisan, Ganghwado, Incheon, South Korea, 21.vi.2014, 140621YR-1, on *Tilia* sp. (Tiliaceae), Y. Lee & H. Lee, CALS SNU.

Host plant. Tilia spp.* (Tiliaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, Japan, Eastern Siberia and Turkey.

Genus *Tinocallis* Matsumura, 1919 느티나무알락진딧물속

Type species: *Tinocallis ulmiparvifoliae* Matsumura, 1919: 101.

Lutaphis Shinji, 1924: 346.

Diagnosis. This genus can be recognized by having narrow transversely elongated or slit-like secondary rhinaria on Ant.III, abdominal tergite III, V and VII with laterally displaced spinal dorsal setae and abdominal dorsum usually with fingerlike tubercles.

Host plant. Betulaceae, Fabaceae, Lythraceae, Juglandaceae, Sapindaceae, Sonneratiaceae and Ulmaceae*.

Distribution. Afrotropical, Australian, Oriental, Nearctic, Neotropical and Palearctic regions.

Remarks. This is large genus comprising 21 species originally distributed throughout Europe across Asia. Recently, some species have been introduced into Africa, Australia and North America. Most species are associated with Ulmaceae. Apterous viviparous females are unknown.

Subgenus *Sappocallis* Matsumura, 1919 느릅알락진딧물아속 (신칭)

Type species: *Sappocallis ulmicola* Matsumura, 1919: 110, 111.

Telecallis Shinji, 1922: 731.

Tuberocallis Nevsky, 1929: 221.

Diagnosis. This subgenus can be recognized by having head and thorax often with dark sclerites, fore wing often with dark pigment on branches of media and apex of cu1b, pro- and mesonotum with spinal elevations or finger like tubercles.

Host plant. Corylus sieboldiana (Betulaceae), *Hemiptelea davidii*, *Ulmus* spp.*, *Zelkova* spp. (Ulmaceae).

Distribution. Neotropic, Nearctic and Palearctic regions.

Remarks. This subgenus comprises 5 species distributed throughout Asia and Europe. Some species have been introduced into North and South America. Except for only one species, *T*. (*S*.) *nikkoensis* Higuchi, all other species occur on plants in Ulmaceae. Apterous viviparous females not known.

Key to species of *Sappocallis* in Korea

1. Media of fore wing once-branced, rarely twice-branched........***T.* (*S.*) *ulmicola***

– Media of fore wing twice branched...**2**

2. Spinal tubercles on 3rd-6th abdominal tergites and marginal tubercles on 1st-6th tergite with dark pigmentation; SIPH black............................***T.* (*S.*) *saltans***

– Abdomen and tubercles on abdominal tergites pale; SIPH pale.........................
.... ***T.* (*S.*) *takachihoensis***

Tinocallis* (*Sappocallis*) *saltans **(Nevsky, 1929)** **애느릅알락진딧물**

Tuberocallis saltans Nevsky, 1929: 221.

Tinocallis saltans Börner, 1952: 62; Quednau, 1954: 28; Richards, 1967: 544; Quednau, 1979: 513; Quednau and Shaposhnikov, 1988: 3030.

Tinocallis yinchuanensis Zhang, 1980: 430, 31.

Tinocallis (*Tinocallis*) *saltans* Remaudière and Remaudière, 1997: 226; Quednau, 2001: 208.

Tinocallis yichuanensis Remaudière and Remaudière, 1997: 226, 227.

Tinocallis (*Sappocallis*) *saltans* Quednau, 2003: 42.

Diagnosis. This species is similar to *T. nevskyi* Remaudière, Quednau & Heie but differ in having 4 accessory setae on URS (T. nevskyi has 5-6 accessory setae on URS), dark apical spots on fore wing and shorter length of 6th antennal segment (T. saltans, Ant.VIb 0.12-0.16mm+PT 0.10-0.11mm; T. nevskyi, Ant.VIb 0.14-0.15mm+PT 0.13-0.15mm).

Description. Alate viviparous female. Color in iife. Head brownish with dark longitudinal band, compound eye red; Ant.I-II dark, Ant.III-VIb with dark distal joint; Pronotum yellowish with dark longitudinal band, mes- and metaonotum dark; Abdomen yellow with dark sclerotized dorsal tubercle, marginal tubercle onabdominal tergite IV-V dark; Legs pale, distal1/3 of HFM dark; SIPH dark; Cauda concolorus with body; Wing vein of fore wing dark, marginal wing vein slightly dark bordered. *Morphology* (Table S74; Fig. S74). Body oval 1.72-2.08mm long; Head with 0.01-0.02mm setae, median protrusion on frons developed, epicranial suture weakly developed, antennal tubercle developed, head dorsum without tubercles; Antenna 6-segmented, 0.68-0.85 times as long as body length, Ant.III with 13-19 transversely elliptical secondary rhinaria in a row on basal 3/5 of the segment, longest setae on Ant.III 0.33 times as long as BDAnt.III, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, Ant.VIb with a single seta, PT 0.67-0.92 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.09-0.10mm long with 6 accessory setae, 0.82-1.00 times as long as 2HT; Pronotum smooth with 2 pairs of spinal tubercle, mesonotum with a pair of spinal tubercle; Fore coxae moderately enlarged; Longest setae on HTB 0.75-1.00 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.10-0.12mm long; Dorsal abdominal tergite I-II with a pair of spinal setae on pale tubercles, abdominal tergite II-VIII with a pair of setae on dark sclerotized elevations, abdominal margin with a single seta on tubercles, 4th and 5th abdominal marginal tubercle dark sclerotized; SIPH cylindrical dark pigmented, 0.06-0.08mm long; Cauda knobbed 0.13-0.14mm long with 11-12 setae; Anal plate bilobed, each lobe with 6-9 setae.

Materials examined. 2 alate viviparous females, Suwon-si, GG, South Korea, 10-15.v.1968, Coll 301, host plant unknown, W.H. Paik, NAAS; 2 alate viviparous females, Seoul, South Korea, 13.vi.1968, Coll 4688, on *Ulmus pumila*, W.H. Paik, NAAS; 4 alate viviparous females, Suwon-si, GG, South Korea, 1-10.v.1970, Coll 301, yellow pan trap, W.H. Paik, NAAS; 2 alate viviparous females, Suwon-si, GG, South Korea, 28.v.1971, Coll 6370, on *Ulmus* sp., W.H. Paik, NAAS; 1 alate viviparous female, Seoul, South Korea, 1-10.x.1971, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 2 alate viviparous females, Seoul, South Korea, 21.x.1971, Coll 6836, on *Ulmus pumila*, W.H. Paik, NAAS; 2 alate viviparous females, Hyesan, North Korea, 28.vi.1988, Coll 88HA3156, on *Ulmus macrocarpa*, J. Havelka, NAAS; 13 alate viviparous females, Soheul-eub, Pocheon-si, GG, South Korea, 21.v.1999, Coll 990521GS-12, on *Ulmus pumila*, G.S. Lee, NAAS; 1 alate viviparous female, Suwon-si, GG, South Korea, 15.v.2003, Coll 030515SH-1, on *Ulmus* sp., S. Lee, CALS SNU.

Host plant. Ulmus spp.* (Ulmaceae); *Zelkova serrata* in Hungary.

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, China, eastern Iran, Tajikistan, Kazakhstan, Uzbekistan, Urals, Afghanistan, Pakistan, Siberia, Spain, Italy, Hungary, Romania, North America, Argentina and Bolivia.

Remarks. This species is widely distributed throughout Europe across Asia and recently introduced into North and South America. Morphologically similar species *T. nevskyi* was previously confused to *T. saltans*.

Tinocallis (_Sappocallis_) _takachihoensis_ Higuchi, 1972 별점느릅알락진딧물 (신칭)

Tinocallis takachihoensis Higuchi, 1972: 44; Quednau and Shaposhnikov, 1988: 1030.

Tinocallis hemipteleae Zhang, 1980: 429, 430.

Tinocallis (*Tinocallis*) *takachihoensis* Remaudière and Remaudière, 1997: 227; Quednau, 2001: 208.

Tinocallis nevskyi lianchengensis Qiao and Zhang, 1998: 370.

Tinocallis (*Sappocallis*) *takachihoensis* Quednau, 2003: 42.

Diagnosis. This species is similar to *T. ulmicola* (Matsumura) by having same body color but, can be recognized by having twice branched media of fore wing (*T. ulmicola* has once branched media of fore wing), 1 pair of spinal tubercle on pronotum (*T. ulmicola* has 2 pairs of spinal tubercle on pronotum), Ant.III with 16-23 transversely elliptical secondary rhinaria (*T. ulmicola* has 11-15 transversely elliptical secondary rhinaria) and SIPH with 1 pointed hair (in *T. ulmicola*, SIPH without hairs).

Description. Alate viviparous female. Color in iife. Head shiny black, compound eye red; Ant.I-II dark, Ant.III-VIb with dark distal joint; Thorax shiny black; Abdomen pale to pale yellow; Legs pale, distal1/3 of HFM dark; SIPH and cauda pale; Wing vein of fore wing with unique dark marking. *Morphology* (Table S75; Fig. S75). Body oval 1.33-2.13mm long; Head with 0.01-0.02mm setae, median protrusion on frons developed, epicranial suture developed, antennal tubercle developed, head dorsum without tubercles; Antenna 6-segmented, 0.84-1.05 times as long as body length, Ant.III with 16-23 transversely elliptical secondary rhinaria in a row on whole segment, longest setae on Ant.III 0.33-0.50 times as long as BDAnt.III, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, PT 0.88-1.14 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.09-0.12mm long with 6 accessory setae, 0.83-1.33 times as long as 2HT; Pro- and mesonotum smooth with a pair of spinal tubercle; Fore coxae moderately enlarged; Longest setae on HTB 0.75-1.00 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.09-0.12mm long; Dorsal abdominal tergite I-II with a pair of spinal setae on tubercles, abdominal tergite II-VIII with a pair of setae on pale elevations, abdominal margin with a single seta on tubercles; SIPH cylindrical 0.04-0.06mm long with a single seta; Cauda knobbed 0.08-0.12mm long with 8-9 setae; Anal plate bilobed, each lobe with 5-8 setae.

Materials examined. 1 alate viviparous female, Mt. Myohyangsan, Yongbyon-gun, PB, North Korea, 25.vi.1987, Coll 87HA1993, on *Ulmus propinqua*, J. Havelka, NAAS; 7 alate viviparous female, SNU arboretum, Gwonseon-gu, Suwon, GG, South Korea, 30.iv.2014, Coll 140430YR-13, on *Ulmus* sp., Y. Lee, CALS SNU; 8 alate viviparous females, Pillye mineral spring, Inje-gun, GW, South Korea, 4.vi.2014, Coll 140604YR-39, on *Ulmus* sp., Y. Lee, CALS SNU; 2 alate viviparous females, Nam-myeon, Yeongwol-gun, GW, South Korea, 12.vi.2014, Coll 140612YR-8, on *Ulmus* sp., Y. Lee, CALS SNU; 3 alate viviparous females, Gyeongbok palace, Jongno-gu, Seoul, South Korea, 14.vi.2014, Coll 140614YR-4, on *Ulmus* sp., Y. Lee & H. Lee, CALS SNU.

Host plant. Ulmus spp.* (Ulmaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, China, Japan, France, Germany, Netherlands, Italy, England, Andorra, Malta, Greece, Turkey and USA.

Remarks. This species is new to Korea. Compared to similar species *T. ulmicola*, more commonly collected in Korea.

Tinocallis (Sappocallis) ulmicola **(Matsumura, 1919) 느릅알락진딧물**

Sappocallis ulmicola (Matsumura, 1919): 110, 111; Shinji and Kondo, 1938: 56; Tao, 1964: 221; Higuchi, 1972: 33; Eastop and Hille Ris Lambers, 1976: 386; Quednau, 1979: 514.

Telocallis alnifoliae Shinji, 1922: 731.

Tinocallis ulmifolii Smith and Parron, 1978: 287.

Tinocallis (*Sappocallis*) *ulmicola* Quednau and Shaposhnikov, 1988: 1030; Quednau, 2003: 42.

Tinocallis (*Tinocallis*) *ulmicola* Remaudière and Remaudière, 1997: 227.

Diagnosis. This species is morphologically similar to *T. takachihoensis* Higuchi but differ in having once branched, rarely twice branched media of fore wing, 2 pairs of spinal tubercles on pronotum, Ant.III with 11-15 transversely elliptical secondary rhinaria and SIPH without seta.

Description. Alate viviparous female. Color in iife. Head shiny black, compound eye red; Ant.I-II black, Ant.III-VIb with dark distal joint; Thorax shiny black; Abdomen pale; Legs pale, distal1/3 of HFM dark; SIPH and cauda pale; Wing vein of fore wing with unique dark marking. *Morphology* (Table S76; Fig. S76). Body oval 1.42-1.91mm long; Head with 0.01-0.02mm setae, median protrusion on frons developed, epicranial suture weakly developed, antennal tubercle developed, head dorsum without tubercles; Antenna 6-segmented, 0.74-0.88 times as long as body length, Ant.III with 11-15 transversely elliptical secondary rhinaria in a row on the whole segment, antennal setae short pointed, longest setae on Ant.III 0.01mm long, Ant.IV-VI imbricated, Ant.IV without secondary rhinaria, PT 0.73-1.20 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.10-0.12mm long with 4-5 accessory setae, 1.11-1.38 times as long as 2HT; Pronotum with two pairs of spinal tubercle, mesonotum smooth with a pair of spinal tubercle; Fore coxae enlarged; Longest setae on HTB 0.75-1.00 times as long as middle width of HTB, first segment of hind tarsi with 7 chaetotaxy, 2HT 0.07-0.10mm long; Dorsal abdominal tergite I-II with a pair of spinal setae on tubercles, abdominal tergite II-VIII with a pair of setae on pale elevations, abdominal margin with a single seta on tubercles; SIPH cylindrical with a single seta, 0.03-0.05mm long; Cauda knobbed 0.08-0.10mm long with 8-9 setae; Anal plate bilobed, each lobe with 5-7 setae.

Materials examined. 1 alate viviparous female, Mt. Yonggaksan, Pyongsong, PN, North Korea, 11.vi.1988, Coll 88HA2957, on *Ulmus macrocarpa*, J. Havelka, NAAS; 2 alate viviparous female, SNU arboretum, Gwonseon-gu, Suwon, GG, South Korea, 30.iv.2014, Coll 140430YR-13, on *Ulmus* sp., Y. Lee, CALS SNU; 16 alate viviparous female, SNU arboretum, Gwonseon-gu, Suwon, GG, South Korea, 30.v.2014, Coll 140530YR-2, on *Ulmus* sp., Y. Lee, CALS SNU.

Host plant. Ulmus spp.* (Ulmaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, China, Japan and Siberia

Remarks. Previously, this species was only recorded from North Korea.

Subgenus *Tinocallis* Matsumura, 1919 느티나무알락진딧물아속 (신칭)

Type species: *Tinocallis ulmiparvifoliae* Matsumura, 1919: 101.

Lutaphis Shinji, 1924: 346.

Diagnosis. This subgenus can be distinguished by having head and thorax without dark sclerites, fore wing often without dark pigment on branches of media and apex of cu1b, Co and Pts sometimes slightly pigmented.

Host plant. Betulaceae, Fabaceae, Lythraceae, Sapindaceae, Sonneratiaceae and Ulmaceae*.

Distribution. Australian, Oriental, Nearctic, Neotropical and Palearctic regions.

Remarks. This subgenus comprises 9 species mostly distributed in Southeast and East Asia except for 1 North American species, *T.* (*T.*) *ulmifolli* (Monell). Recently, some species have been introduced into Australia, North and South America. Tinocallis species associated with various host plants belonging to Betulaceae, Fabaceae, Lythraceae, Sapindaceae, Sonneratiaceae and Ulmaceae. Apterous viviparous females not known.

Key to species of *Tinocallis* in Korea

1. Head dorsum with 3-4 pairs of spinal tubercles **2**

– Head dorsum without spinal tubercles **3**

2. Spinal tubercles without wax gland pores......................***T.* (*T.*) *ulmiparvifoliae***

– Apices of spinal tubercles with cribriformed wax gland pores .....***T.* (*T.*) *viridis***

3. URS 1.22-1.63 times as long as 2HT; URS with 6-10 accessory setae ....

....***T.* (*T.*) *mushensis***

– URS 0.78-1.20 times as long as 2HT; URS with 4-5 accessory setae **4**

4. Whole antenna 0.86-1.13 times as long as body length ....

.... ***T.* (*T.*) *latifoliae* sp. nov.**

– Whole antenna 0.53-0.79 times as long as body length ....***T.* (*T.*) *zelkowae***

***Tinocallis (Tinocallis) latifoliae* Lee, sp. nov. 둥근잎느티나무알락진딧물 (신칭)**

Diagnosis. This species is superficially similar to *T. zelkowae* (Takahashi) but can be distinguished by having small body size 1.19-1.47mm, whole antenna 0.86-1.13 times as long as body length and pigmented spinal tubercles on abdominal tergites I-VIII.

Description. Alate viviparous female. Color in iife. Head pale with longitudinal dark stripe, compound eye pale; antenna pale, Ant.III-VI with dark distal joint; legs pale, tip of tarsus slightly dark; Prothorax pale with dark longitudinal band, meso- and meta thorax pale; Abdomen pale with pigmented dorsal spinal tubercles; SIPH and cauda pale; Fore wing without unique dark markings. *Morphology* (Table S77; Fig. S77). Body oval, 1.19-1.47 mm long, Head slightly wrinkled with 0.01-0.03mm short and pointed setae, epicranial suture poorly developed, antennal tubercle developed; Antenna 6-segmented, 0.86-1.13 times as long as body length, Ant.I-II faintly imblicated, Ant.III-VI imblicated, antennal setae short and pointed shape, Ant.III with 16-26 slit-like secondary rhinaria in a row on basal 3/4, antennal setae short and pointed, longest setae on Ant.III 0.50 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, Ant.VIb with 1-2 0.01mm of setae, PT 0.53-0.83 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.07-0.08mm long with 4-5 accessory setae, 0.78-1.00 times as long as 2HT; Longest setae on HTB 0.67-1.00 times as long as middle width of HTB, hind first tarsal chaetotaxy 7; Thorax without spinal tubercle; Abdominal dorsal tergite I-II with a pair of spinal tubercles, abdominal dorsal tergite III-VIII with a pair of pigmented elevation; abdominal margin I-IV with tubercles; SIPH 0.02-0.03mm long; Cauda knobbed, 0.09-0.10mm with 7-10 long and fine setae; Anal plate bilobed, each lobe with 7-9 setae.

Types. *Holotype*. 1 alate viviparoud female, Mt. Chilgapsan, Cheongyang-gun, CN, South Korea, 10.v.2014, Coll 140624YR-3, on *Zelkova serrata* (var. *latifoliae*), Y. Lee & H. Lee, CALS SNU; Paratypes. 3 alate viviparous females, same data as the holotype; 1 alate viviparous female, Chiak-recration forest, Wonju-si, GW, South Korea, 29.viii.2013, Coll 130829YR-13, on *Z. serrata* (var. *latifoliae*), Y. Lee, CALS SNU; 4 alate viviparoud females, Yeongwol-gun, GW, South Korea, 24.vi.2014, Coll 140624YR-2 on *Z. serrata* (var. *latifoliae*), Y. Lee, CALS SNU; 3 alate viviparoud females, Kimsatgat-myeon, Yeongwol-gun, GW, South Korea, 24.vi.2014, Coll 140624YR-7 on *Z. serrata* (var. *latifoliae*), Y. Lee, CALS SNU.

*Host plant. Zelkova serrata** (var. *latifoliae*) (Ulmaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea.

Remarks. This species is relatively rare and only collected on native *Z. serrata* (var. *latifoliae*) growing in Korean mountain area.

***Tinocallis* (*Tinocallis*) *mushensis* (Takahashi, 1925) 노랑느티나무알락진딧물 (신칭)**

Myzocallis mushensis Takahashi, 1925: 45.

Tinocallis mushensis Eastop and Hille Ris Lambers, 1976: 291.

Tinocallis (*Tinocallis*) *mushensis* Remaudière and Remaudière, 1997: 226; Quednau, 2001: 210; Quednau, 2003: 44.

Diagnosis. This species can be recognized from closely related species *T. zelkowae* by having dark pigmented head vertex and Ant.I-II, Ant.III with 24-30 secondary rhinaria, URS 1.22-1.63 times as long as 2HT, URS with 6-10 accessory setae and longer rostrum barely reaching to middle coxae.

Description. Alate viviparous female. Color in iife. Head yellow with longitudinal dark stripe, head vertex dark, compound eye pale; Ant.I-III dusky, Ant.III-VIb dark distal joint; Fore legs dusky, middle and hind legs pale, tip of tarsus slightly dark; Thorax pale yellow with dark longitudinal band, abdomen pale yellow with dark dorsal spinal tubercles; SIPH dark; Cauda pale to slightly pigmented; Wing vein of fore wing dark. *Morphology* (Table S78; Fig. S78).

Body oval, 1.59-1.96 mm long, Head slightly wrinkled with 0.01mm short and pointed setae, epicranial suture developed, median protrusion on frons developed, antennal tubercle developed; Antenna 6-segmented, 0.76-0.90 times as long as body length, Ant.IV-VI imblicated, Ant.III with 24-30 slit-like secondary rhinaria in a row on whole surface, longest setae on Ant.III 0.33 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, Ant.VIb with 0.01mm of setae. PT 0.67-1.00 times as long as Ant.VIb; Rostrum relatively long, barely reaching to middle coxae, URS 0.11-0.14mm long with 7-8 accessory setae, 1.22-1.63 times as long as 2HT; Longest setae on HTB same as middle width of HTB, hind first tarsal chaetotaxy 8; Thorax without spinal tubercle; Abdominal dorsal tergite I-II with a pair of spinal setae on tubercles, abdominal dorsal tergite III-VIII with a pair of spinal setae on elevation; abdominal margin I-IV a single seta on tubercles; SIPH 0.03-0.06mm long; Cauda knobbed, 0.09-0.11mm with 10-12 setae; Anal plate bilobed, each lobe with 5-7 setae.

Materials examined. 18 alate viviparous females, Jeongan service area, Gongju, CN, South Korea, 28.vii.2013, Coll 130728YR-36, on *Zelkova serrata*, Y. Lee, CALS SNU; 6 alate viviparous females, SNU, Gwanak-gu, Seoul, South Korea, 5.ix.2013, Coll 130905YR-2, on *Z. serrata*, Y. Lee, CALS SNU; 2 alate viviparous females, Yangpyeong-gun, GG, South Korea, 12.vi.2015, Coll 150612Tino-2, on *Castanea* sp., Y. Lee, CALS SNU.

*Host plant. Zelkova serrata** (Ulmaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea and Taiwan.

Remarks. This species is new to Korea. Previously, this species was only collected in Taiwan.

***Tinocallis* (*Tinocallis*) *ulmiparvifoliae* Matsumura, 1919 머리혹알락진딧물**

Tinocallis ulmiparvifoliae Matsumura, 1919: 220; Eastop, 1966: 522; Richards, 1967: 548; Higuchi, 1972: 45.

Agrioaphis ulmi-parvifoliae Takahashi, 1935: 500.

Tinocallis (*Tinocallis*) *ulmiparvifoliae* Remaudière and Remaudière, 1997: 227; Quednau, 2001: 208; Quednau, 2003: 45.

Diagnosis. This species is easily recognized from any other congeneric species by having 3 pairs of well-developed spinal tubercles and 1 pair of small elevation on head dorsum and URS 0.72-0.82 times as long as 2HT.

Description. Alate viviparous female. Color in iife. Head yellowish green, with longitudinal white wax markings, compound eye pale; antenna pale, Ant.III-VI with dark distal joint; legs pale, tip of tarsus slightly dark; Thorax and abdomen yellowish green with white wax markings, dorsal abdominal tubercle slightly pigmented; SIPH and cauda pale; Wing veins of fore wing dark. *Morphology* (Table S79; Fig. S79). Body oval, 2.06-2.52 mm long; Head slightly wrinkled with 0.01mm short and pointed setae, head vertex with a pair of tubercles, epicranial suture developed, median protrusion on frons developed, antennal tubercle developed, head dorsum with two pairs of dorsal spinal tubercles; Antenna 0.74-0.80 times as long as body length, Ant.I-II faintly imblicated, Ant.III-VI imblicated, antennal setae short and pointed shape, Ant.III with 19-26 slit-like secondary rhinaria in a row on almost whole surface, longest setae on Ant.III 0.33-0.50 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, Ant.VIb with 0.01mm of short and pointed seta, PT 0.73-0.89 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.08-0.09mm long with 5-6 accessory setae, 0.73-0.82 times as long as 2HT; Longest setae on HTB 0.60-1.00 times as long as middle width of HTB, hind first tarsal chaetotaxy 7; Pronotum with two pairs of spinal tubercles, mesonotum with a pair of distinct tubercles; Abdominal dorsal tergite I-II with a pair of spinal setae on conspicuous tubercles, abdominal dorsal tergite III-VIII with a pair of spinal setae on elevations; abdominal margin I-IV with a single seta on tubercles; SIPH 0.04-0.08mm long; Cauda knobbed, 0.15-0.17mm with 13-17 setae; Anal plate bilobed, each lobe with 7-10 setae.

Materials examined. 1 alate viviparous female, Suwon, GG, South Korea, 21-30.vi.1968, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Suwon, GG, South Korea, 21-30.viii.1968, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Suwon, GG, South Korea, 27.x.1969, Coll 5637, on *Ulmus* sp., W.H. Paik, NAAS; 4 alate viviparous females, Suwon, GG, South Korea, 8.vi.1971, Coll 6398, on *Ulmus* sp., W.H. Paik, NAAS; 1 alate viviparous female, Suwon, GG, South Korea, viii.1971, Coll unknown, host plant unknown, W.H. Paik, NAAS; 3 alate viviparous females, Suwon, GG, South Korea, 31.x.1971, Coll 6871, on *Ulmus* sp., W.H. Paik, NAAS; 17 alate viviparous females, Gyeongbok palace, Jongno-gu, Seoul, South Korea, 14.vi.2014, 140614YR-3, on Ulmus sp, Y. Lee & H. Lee, CALS SNU.

Host plant. Ulmus spp.* (especially on *U. parvifolia*) (Ulmaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, China, Taiwan, Australia, USA, England, Italy and Spain.

Remarks. This species is originally distributed in Asia and recently introduced into Australia, Europe and North America.

Tinocallis (_Tinocallis_) _viridis_ (Takahashi, 1929) 초록느티나무알락진딧물 (신칭)

Myzocallis viridis Takahashi, 1929: 252.

Tinocallis ulmi-parvifoliae Tao, 1964: 220.

Tinocallis viridis Eastop and Hille Ris Lambers, 1976: 292.

Tinocallis allozelkowae Zhang, 1980: 430, 431.

Tinocallis (*Tinocallis*) *viridis* Remaudière and Remaudière, 1997: 227; Quednau. 2001: 209; Quednau, 2003: 45.

Diagnosis. This species is closely related to *T. ulmiparvifoliae* but can be distinguished by having 4 pairs of elevations on head dorsum, 10-16 transversely elliptical secondary rhinaria on Ant.III, ending of wing veins with dark apical spots, SIPH relatively long and dark pigmented 0.06-0.11mm.

Description. Alate viviparous female. Color in iife. Head yellowish green to grayish green with longitudinal white wax marking, compound eye red; Ant.I-II dusky, distal joint of Ant.III, distal half of Ant.IV-VI dark; Tibiae and distal 1/3 of femur dusky; Thorax and abdomen yellowish green to dirty green with white wax markings, tip of spinal tubercles on thorax and abdominal dorsum pigmented; SIPH and cauda dusky; Marginal wing vein of fore wing dark borered. *Morphology* (Table S80; Fig. S80). Body oval, 1.85-2.49mm long; Head with 0.01-0.02mm short and pointed setae, head vertex with a pair of spinal tubercle, epicranial suture poorly developed, median protrusion on frons developed, antennal tubercle developed; Antenna 6-segmented, 0.79-1.02 times as long as body length, Ant.I-III faintly imblicated, Ant.IV-VI imblicated, antennal setae short and pointed shape, Ant.III with 10-16 slit-like secondary rhinaria in a row on basal 1/3, longest setae on Ant.III 0.33 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, Ant.VIb with a single hair like seta, PT 0.54-0.73 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.10-0.12mm long with 6-10 accessory setae, 1.00-1.22 times as long as 2HT; Longest setae on HTB 0.75-1.00 times as long as middle width of HTB, hind first tarsal chaetotaxy 7; Pro- and mesothorax with a pair of spinal setae on tubercle; Abdominal dorsal tergite I-II with a pair of spinal setae on tubercles, spinal tubercle on dorsal tergite II broadly fused basally, abdominal dorsal tergite III-VIII with a pair of spinal setae on pigmented elevation; abdominal margin I-IV with a pointed seta on tubercles; SIPH 0.06-0.11mm long; Cauda knobbed, 0.13-0.17mm with 7-8 long; Anal plate bilobed, each lobe with 6-9 setae.

Materials examined. 24 alate viviparous females, Gurodigital subway station, Guro-gu, Seoul, South Korea, 4.xi.2014, Coll 141104YR-1, on Z. serrata, Y. Lee & H. Lee, CALS SNU.

Host plant. Zelkova spp.* (Ulmaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, China and Taiwan.

Remarks. This species is new to Korea.

***Tinocallis* (*Tinocallis*) *zelkowae* (Takahashi, 1929) 느티나무알락진딧물**

Myzocallis zelkowae Takahashi, 1919: 173.

Lutaphis alnifoliae Shinji, 1924: 347.

Lutaphis nirecola Shinji, 1924: 347.

Sarucallis zelkowae Tao, 1964: 225.

Tinocallis zelkowae Richards, 1967: 550.

Tinocallis (*Tinocallis*) *zelkowae*: Remaudière and Remaudière, 1997: 227; Quednau, 2001: 211; Quednau, 2003: 44.

Diagnosis. This species is closely related to *T. latifoliae* **sp. nov.** but can be distinguished by having large body size 1.63-2.47mm and relatively short length of antenna, 0.53-0.79 times as long as body length.

Description. Alate viviparous female. Color in iife. Head pale to yellow without dark stripes, compound eye pale; antenna pale, Ant.III-VI with dark distal joint; legs pale, tip of tarsus slightly dark; Prothorax pale with dark longitudinal band, meso- and meta thorax pale; Abdomen pale; SIPH and cauda pale; Fore wing without dark markings. *Morphology* (Table S81; Fig. S81). Body oval, 1.63-2.47 mm long; Head slightly wrinkled with 0.01mm short and pointed setae, epicranial suture developed, median protrusion on frons developed, antennal tubercle developed; Antenna 6-segmented, 0.53-0.79 times as long as body length, Ant.I-II faintly imblicated, Ant.III-VI imblicated, antennal setae short and pointed shape, Ant.III with 16-23 slit-like secondary rhinaria in a row on basal 3/4, longest setae on Ant.III 0.33-0.50 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, Ant.VIb with 0.01mm hair like seta, PT 0.47-0.71 times as long as Ant.VIb; Rostrum not reaching to middle coxae, URS 0.08-0.13mm long with 4-6 accessory setae, 0.80-1.20 times as long as 2HT; Longest setae on HTB 0.75-1.33 times as long as middle width of HTB, hind first tarsal chaetotaxy 7; Thorax without spinal tubercle; Abdominal dorsal tergite I-II with a pair of spinal tubercles, abdominal dorsal tergite III-VIII with a pair of pigmented elevation; abdominal margin I-V with tubercles; SIPH 0.03-0.05mm long; Cauda knobbed, 0.10-0.14mm with 8-10 long and fine setae; Anal plate bilobed, each lobe with 6-7 setae.

Materials examined. 1 alate viviparous female, Suwon-si, South Korea, 11.x.1966, Coll 303, on *Zelkova serrata*, W.H. Paik, NAAS; 2 alate viviparous females, Seoul-si, South Korea, 21.x.1971, Coll 6838, on *Zelkova serrata*, W.H. Paik, NAAS; 2 alate viviparous females, Parkyon falls, Gaeseong, HB, North Korea, 2.vii.1985, Coll 85HA1006, on *U. macrocarpa*, J. Havelka, NAAS; 5 alate viviparous females, Maetan-dong, Gwonseon-gu, Suwon, GG, South Korea, 17.v.1999, Coll 990517SH-2, on *Z. serrata*, S.H. Lee, NAAS; 3 alate viviparous females, Dangu-dong, Wonju, GW, South Korea, 2.v.1999, Coll 990502-SH1, on *Z. serrata*, S.H. Lee, NAAS; 3 alate viviparous females, Do-dong, Ulreung-eub, Ulreung-gun, GB, South Korea, 5.vi.2000, Coll 000605-SH27, on *Zelkova* sp., S.H. Lee, NAAS; 14 alate viviparous females, Gwonseon-gu, Suwon-si, GG, South Korea, 13.v.20005, Coll 050513HJ-1, on *Z. serrata*, H. Kim, CALS SNU; 13 alate viviparous females, Ewha womans University, Daehyeon-dong, Seodaemun-gu, Seoul, South Korea, 12.v.2013, Coll 130512YR-4, on *Z. serrata*, Y. Lee and H. Lee, CALS SNU; 12 alate viviparous females, SNU, Gwanak-gu, Seoul, South Korea, 24.v.2013, Coll 130524YR-1, on *Z. serrata*, Y. Lee, CALS SNU; 8 alate viviparous females, Seoklim-dong, Seosan-si, CN, South Korea, 8.vi.2013, Coll 130608HS-3, on *Wisteria floribunda* (Fabaceae), H. Lee, CALS SNU.

Host plant. Zelkova spp.* (Ulmaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves.

Distribution. Korea, China, Taiwan, Australia, USA, England, Italy and Spain.

Remarks. This is one of the most common species in Korea. Originally distributed in Asia and recently introduced into Australia, Europe and North America.

1.3.2. Subfamily **Phyllaphidinae Herrich-Schaeffer, 1857** **너도밤나무가루진딧물아과 (신칭)**

Type genus: *Phyllaphis* Koch, 1856: 248.

The subfamily Phyllaphidinae comprising about 18 species under 4 genera worldwide (Favret, 2017), is characterized (Fig. 1.10.) by Ant.II often longer than Ant.I, PT much shorter than Ant.VIb, first tarsal segment without dorsal setae, antenna, abdominal dorsum and leg with extended wax plant plates on sclerites, media of fore wing sometimes once branched, cauda rounded, SIPH poriform.

Key to the genera of Phyllaphidinae

1. Cauda with wax gland pore, trochanter fused with femur............***Diphyllaphis***

- Cauda without wax gland pore, trochanter separated with femur.....................**2**

2. Triommatidium not separated to compound eye, anal plate in alate viviparous female rounded.. ***Machilaphis***

- Triommatidium distinct but small, anal plate in alate viviparous female bilobed
....
....***Phyllaphis***

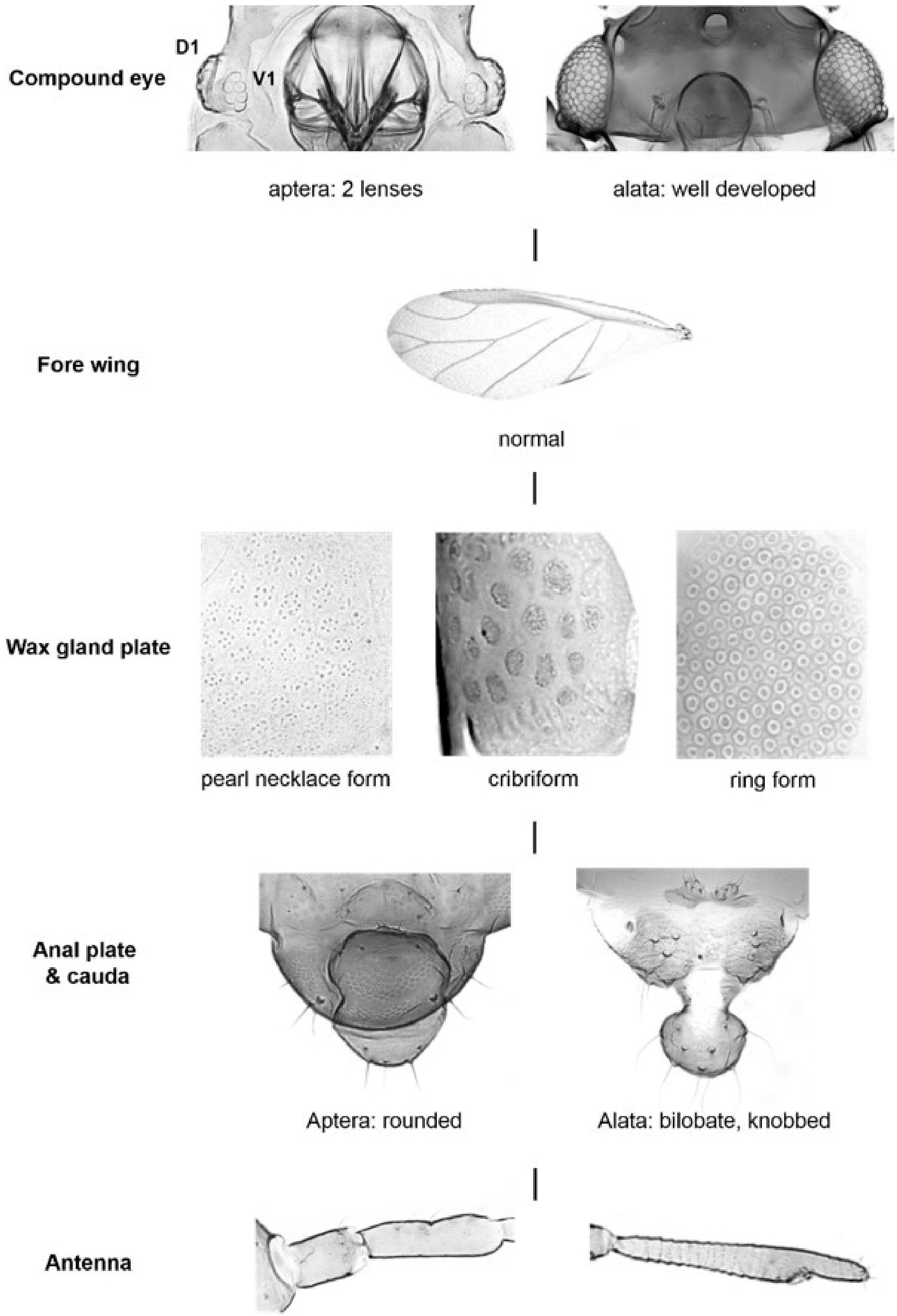

Fig. 1.10. Morphological characteristics of the subfamily Phyllaphidinae

Genus *Diphyllaphis* Takahashi, 1960 둥글무늬가루진딧물속 (신칭)

Type species: *Phloeomyzus konarae* Shinji, 1924: 369.

Diagnosis. This genus is similar to *Strgophylla* Oestlund but can be recognized by having suphuncular opening 2-3 times as long as diameter of surrounding wax gland plate with 1-2 setae and less hairs on abdominal tergite VIII.

Host plant. Quercus spp.* (Fagaceae).

Distribution. Nearctic and Palearctic region.

Remarks. This is small genus comprising 5 species under 2 subgenera mostly distributed in Palearctic region. All species are associated with *Quercus* spp. (Fagaceae).

Subgenus *Diphyllaphis* Takahashi, 1960 둥글무늬가루진딧물아속 (신칭)

Type species: *Phloeomyzus konarae* Shinji, 1924: 369.

Diagnosis. This genus is recognized from *Nymphaphis* Takahashi by having secondary rhinaria on Ant.III in alate viviparous female, URS pointed shape and empodial seta rod or spatulate shaped.

Host plant. Quercus spp.* (Fagaceae).

Distribution. Nearctic, and Palearctic region.

Remarks. This subgenus comprises 3 East Asian species and 1 North American species. All species are associated with *Quercus* spp. (Fagaceae). Apterous viviparous female commonly occur.

***Diphyllaphis* (*Diphyllaphis*) *konarae* (Shinji, 1924) 둥글무늬가루진딧물 (신칭)**

Phloeomyzus konarae Shinji, 1924: 369.

Diphyllaphis konarae Takahashi, 1960: 12; Hille Ris Lambers, 1966: 615; Higuchi, 1972: 72; Remaudière & Remaudière, 1997: 252.

Aplonervoides erythrocereus Zhang, 1992: 138, 173.

Diphyllaphis (*Diphyllaphis*) *konarae* Quednau, 2010: 62.

Diagnosis. This species can be distinguished from congeneric species by having abdominal tergite V-VII sclerotic fused, abdominal tergite VIII with 2 pairs of spinal setae.

Description. Apterous viviparous female. Color in iife. Head dusky, compound eye red; Ant.I-II and Ant.V-VI slightly dark, Ant.III-IV pale; Legs pale; Thorax dusky; Abdomen pale with dark spot; Entire body covered with whitish wax. *Morphology* (Table S82; Fig. S82). Body oval, 1.03-1.59mm long; Head surface sclerotized with cribriform wax gland pores, head with 0.01-0.02mm short and pointed setae, epicranial suture not developed, antennal tubercle poorly developed; Antenna short, 6-segmented, 0.31-0.39 times as long as body length, Ant.I-II faintly imblicated, Ant.III-VI imblicated, Ant.III without secondary rhinaria, longest setae on Ant.III 0.33-0.50 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT short 0.17-0.30 times as long as Ant.VIb, Ant.VIb with 0.02-0.03mm long of 2 hairs; Rostrum reaching to middle coxae, URS pointed shaped 0.07-0.17mm long with 2 accessory setae, 0.88-1.27 times as long as 2HT; Longest setae on HTB 0.75 times as long as middle width of HTB, hind first tarsal chaetotaxy 2; Thorax fused with abdomen; Abdomen with sclerotized wax gland plates, abdominal tergites V-VII fused, entirely sclerotic, abdominal margin with a single seta on sclerotic wax gland patch, abdominal tergite VIII with 2 spinal setae; SIPH small sized poriform with 0.03-0.04mm diameter; Cauda rounded, 0.04mm long with 2-3 short setae; Anal plate rounded with 4 short setae.

Materials examined. 1 apterous viviparous female, Jeongeub-si, JB, South Korea, 29.ix.1963, Coll 2941, on *Quercus acutissima*, W.H. Paik, NAAS; 6 apterous viviparous females, Chungju-lake, Mureung-ri, Salmi-myeon, Chungju-si, CB, South Korea, 12.vii.2001, Coll 010712GM-17, on *Quercus serrata*, G.M. Kwon, NAAS; 2 apterous viviparous females, SNU, Gwanak-gu, Seoul, South Korea, 17.v.1999, Coll 990517SH-2, on *Quercus acutissima*, Y. Lee & H. Lee, CALS SNU.

Host plant. Quercus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves. Cause leaf roll-peudogall.

Distribution. Korea, and Japan.

Remarks. This species is relatively very rare. Only apterous viviparous female is known.

Subgenus *Nymphaphis* Takahashi, 1960 갈참나무가루진딧물아속

Type species: *Nymphaphis quercus* Takahashi, 1960: 11, 14.

Diagnosis. This subgenus is characterized by having without secondary rhinaria on Ant.III and hair like empodial setae.

Host plant. Quercus spp.* (Fagaceae).

Distribution. Palearctic region.

Remarks. This is monospecific subgenus infesting on *Quercus* spp. (Fagaceae). Only distributed in East Asia. Apterous viviparous female unknown.

Diphyllaphis (*Nymphaphis*) *quercus* (Takahashi, 1960) 갈참나무가루진딧물

Nymphaphis quercus Takahashi, 1960: 11, 14.

Diphyllaphis quercus Hille Ris Lambers, 1966: 615; Quednau, 1971: 1088; Higuchi, 1972: 72; Quednau, 1979: 501.

Diphyllaphis (*Nymphaphis*) *quercus* Quednau, 2010: 61.

Diagnosis. This species can be distinguished by having head vertex only with double contoured wax gland pores, Ant.III without secondary rhinaria in both alate and apterous viviparous female and hair like empodial setae.

Description. Apterous viviparous female. Color in iife. Head pale, compound eye red; Entire body pale to yellowish; Antenna pale; Legs pale, Body entirely covered with whitish wax. *Morphology* (Table S83; Fig. S83). Body oval, 1.47-2.39mm long; Head surface not sclerotized with cribriform wax gland pores, epicranial suture poorly developed, head dorsum with 0.03-0.04mm setae, antennal tubercle poorly developed; Antenna short, 6 segmented, 0.43-0.61 times as long as body length, Ant.I-III with faintly developed wax gland pores, Ant.IV-VI imblicated, Ant.III without secondary rhinaria, longest setae on Ant.III 0.67-1.00 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT short 0.24-0.31 times as long as Ant.VIb, Ant.VIb with 0.02-0.03mm long of 2 hairs; Rostrum not reaching to middle coxae, URS pointed shaped 1.44-1.56mm long with 2 accessory setae, 0.64-0.69 times as long as 2HT; Longest setae on HTB 0.75-1.00 times as long as middle width of HTB, hind first tarsal chaetotaxy 3; Thorax fused with abdomen, abdomen with sclerotized wax gland plates, abdominal tergite VIII with 4 setae, abdominal margin with a single seta on sclerotic wax gland patch; SIPH small sized poriform 0.01mm of diameter; Cauda rounded, 0.04-0.06mm long with 2-4 setae; Anal plate rounded with 2-4 short setae.

Materials examined. 1 apterous viviparous female, Cheonwoon temple, JN, South Korea, 27.viii.1963, Coll 2379, on *Quercus acutissima*, W.H. Paik, NAAS; 1 apterous viviparous female, Cheongju-si, CN, South Korea, 1.xi.1963, Coll 3072, host plant unknown, W.H. Paik, NAAS; 4 apterous viviparous females, Suwon-si, GG, South Korea, 26.x.1971, Coll 6855, *Quercus aliena*, W.H. Paik, NAAS; 2 apterous viviparous females, Suwon-si, GG, South Korea, 8.xi.1971, Coll 6944, *Quercus* sp., W.H. Paik, NAAS; 12 apterous viviparous females, Daebudo, Hwaseong, GG, South Korea, 18.x.2000, Coll 001018SH-8, on *Quercus* sp., S. Lee, NAAS; 17 apterous viviparous females, Seonsan-service area, Gumi-si, South Korea, 25.viii.2012, Coll 120825YR-1, on *Quercus acutissima*, Y. Lee, CALS SNU; 7 apterous viviparous females, Taean-gun, CN, South Korea, 23.viii.2014, Coll 140823HS-1, on *Quercus acutissima*, H. Lee, CALS CNU.

Host plant. Quercus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves. Cause leaf roll-peudogall.

Distribution. Korea, China, and Japan.

Remarks. This species is one of the most common species in Korea.

Genus *Machilaphis* Takahashi, 1960 후박나무가루진딧물속 (신칭)

Type species: *Phyllaphis machili* Takahashi, 1960: 10, 11.

Diagnosis. This genus is recognized by having pale body, Triommatidium not separated to compound eye and rounded anal plate in alate viviparous female.

Host plant. *Machilus* spp.* (Lauraceae).

Distribution. Oriental and Palearctic region.

Remarks. This is small genus with only 2 described species. *Machihlaphis* species are originally distributed in South-east Asia. All species are associated with *Machilus* spp. (Lauraceae). Apterous viviparous female commonly occur.

***Machilaphis machili* Takahashi, 1960 후박나무가루진딧물**

Machilaphis machili Takahashi, 1960: 11; Higuchi, 1972: 73; Remaudière &

Remaudière, 1997: 252; Quednau, 2010: 60.

Phyllaphis machili Tao. 1964: 210.

Shivaphis cinnamomophila Zhang, 1985: 219.

Diagnosis. This species can be recognized from only congeneric species *M. pseudomachili* Quednau by having 6-8 accessory setae, alate viviparae 0-4 secondary rhinaria on Ant.III.

Description. Apterous viviparous female. Color in iife. Head pinkish, compound eye red; Ant.I dusky, distal joint of Ant.II-VI dark; Legs pale to slightly dusky; Abdomen yellowish green; Body entirely covered with witish wax. *Morphology* (Table S84; Fig. S84). Body eleongated oval, 1.95-2.12mm long; Head surface not sclerotized with ring shaped wax gland pores, epicranial suture poorly developed, head dorsum with 0.02-0.03mm setae, antennal tubercle poorly developed; Antenna 6-segmented, 0.59-0.66 times as long as body length, Ant.I-II and distal joint of Ant.III-IV with faintly developed wax gland pores, Ant.IV-VI imblicated, Ant.III without secondary rhinaria, longest setae on Ant.III 0.67-1.00 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT short 0.14-0.22 times as long as Ant.VIb, Ant.VIb with 2 short hairs 0.01mm long; Rostrum reaching to middle coxae, URS blunted shaped 0.09-0.10mm long with 5-8 accessory setae, 0.73-0.75 times as long as 2HT; Longest setae on HTB 0.75 times as long as middle width of HTB, hind first tarsal chaetotaxy 4; Thorax fused with abdomen, abdomen with pale wax gland plates, abdominal tergites VII-VIII fused with sclerotic patch, abdominal tergite VIII with 5-6 spinal setae, abdominal margin with sclerotic wax gland patch; SIPH small sized poriform 0.01mm; Cauda tongue shaped, 0.08-0.11mm long with 4-7 setae; Anal plate rounded with 3-4 short setae.

Materials examined. 14 apterous viviparous females, Mt. Manheung, Yeosu-si, JN, South Korea, 22.vi.2014, Coll 140622YR-1, on *Machilus thunbergi*, G. Cho, CALS SNU.

*Host plant. Machilus thunbergi** (Lauraceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves. Leaf roll.

Distribution. Korea, China, Taiwan, Thailand, and India.

Remarks. This species is new to Korea.

Genus *Phyllaphis* Koch, 1856 너도밤나무가루진딧물속 (신칭)

Type species: *Chermes fagi* Linnaeus, 1761: 263.

Phegirus Amyot, 1847: 480.

Phillaphis Del Guercio, 1900: 113.

Phyllapis Cholodkovsky, 1910: 147.

Diagnosis. This genus can be recognized by having memebranous broad empodial setae, triommatidium distinct but small and SIPH surrounding with double contoured rign-shaped wax gland pores,

Host plant. *Fagus* spp.* (Fagaceae).

Distribution. Australian, Nearctic, Neotropical and Palearctic region.

Remarks. This is small genus comprising 4 species in the world. All species are associated with *Fagus* spp. (Fagaceae). Apterous viviparous female commonly unknown.

Phyllaphis fagifoliae Takahashi, 1919 너도밤나무가루진딧물

Phyllaphis fagifoliae Takahashi, 1919: 133; 1923: 133; 1937: 91; Richards, 1973: 1577; Quednaul, 2010: 60.

Phyllaphis fagi Higuchi, 1972: 74.

Diagnosis. This species is similar to *P. fagi* (Linnaeus) but can be distinguished by having cribri form wax gland pores on posterior margin of thorlax and tarsus and antenna not pigmented.

Description. Apterous viviparous female. Color in iife. Not available. *Morphology* (Table S85; Fig. S85). Body eleongated oval, 1.24-1.33mm long; Head surface with ring shaped wax gland pores, epicranial suture absent, head with 0.02-0.03mm setae, antennal tubercle poorly developed; Antenna 6 segmented, 0.56-0.67 times as long as body length, Ant.I-II and distal joint of Ant.III-IV with faintly developed wax gland pores, Ant.IV-VI imblicated, Ant.III without secondary rhinaria, longest setae on Ant.III 1.00-1.50 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT short 0.28-0.33 times as long as Ant.VIb, Ant.VIb with 0-1 inconspicuous hairs; Rostrum passing through middle coxae, URS 0.07-0.08mm long with 4 accessory setae, 0.64-0.73 times as long as 2HT; Longest setae on HTB 1.00-1.50 times as long as middle width of HTB, hind first tarsal chaetotaxy 5; Thorax fused with abdomen, abdominal tergite I-VI with 2 pairs of spinal setae on pale wax gland plates, abdominal tergites VIII with 6 spinal setae, abdominal margin with pale wax gland patch; SIPH small sized poriform with 0.03mm diameter; Cauda tongue shaped, 0.06-0.09mm long with 5 setae; Anal plate transversly rounded with 4-6 setae.

Materials examined. 3 apterous viviparous females, Nari basin, Ulreung-eub, Is. Ulreung, GB, South Korea, 7.vi.2000, Coll 000605SH-55, on *Fagus crenata*, S. Lee, NAAS; 4 apterous viviparous females, Nari basin, Ulreung-eub, Is. Ulreung, GB, South Korea, 6.viii.2014, Coll 140806YR-6, on *Fagus crenata*, Y. Lee & H. Lee, CALS SNU.

Host plant. Fagus spp.* (Fagaceae).

Biology. Monoecius holocyclic lifecycle. On underside of leaves. Cause leaf roll pseudo gall.

Distribution. Korea, and Japan.

Remarks. This species is relatively very rare species which has been only collected in Is. Ulreung in Korea. This species was misidentified as *P. fagi* based on only 1 specimen of alate viviparous female by Quednau & Lee (2001).

1.3.3. Subfamily **Saltusaphidinae Baker, 1920 사초진딧물아과 (신칭)**

Type genus: *Saltusaphis* Theobald, 1915: 138.

The subfamily Saltusaphidinae comprising about 56 species under 12 genera of 2 tribes worldwide (Favret, 2017), is characterized by body shape elongated, body surface extensively spiculose, wax gland pore elements often developed, head often with well developed median protrusion, abdomen dorso-ventrally flattened with various shaped dorsal setae such as fan-shaped, flabellate, mushroom- or umbrella shaped, abdominal dorsal tubercle sometimes developed, abdominal margin without marginal tubercle, rostrum very short, SIPH very short poriform or short cylindrical, cauda knobbed. Viviparous female apterous and alate. Mostly distributed in northern temperate region.

Key to the tribes of Saltusaphidinae (Fig. 1.11.)

1. Body narrow elongate and flattend, legs normal, fore wing without dark spots .... **Thripsaphidini**

- Body sometimes arched dorsally, fore and middle legs saltatorial with enlarged femora, fore wing with dark spots.. **Saltusaphidini**

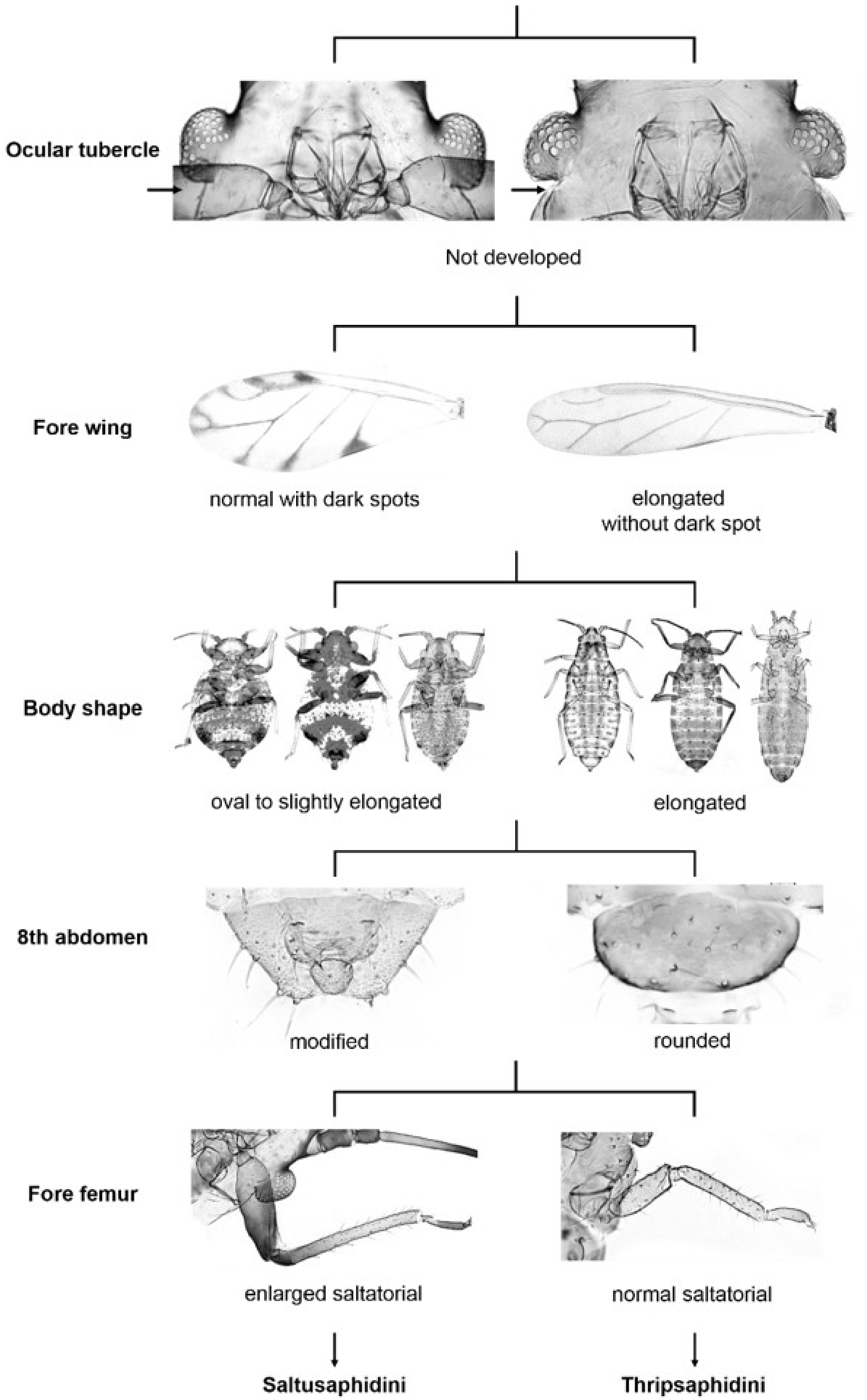

Fig. 1.11. Pictorial key to the tribes of the subfamily Saltusaphidinae

Tribe Saltusaphidini Baker, 1920 사초진딧물족 (신칭)

Type genus: *Saltusaphis* Theobald, 1915: 138.

Hiberaphis Börner, 1949: 52.

Saultusaphis Baker, 1917: 431.

Genus *Saltusaphis* Theobald, 1915 사초진딧물속 (신칭)

Saltusaphis Theobald, 1915: 138.

Diagnosis. This genus is recognized by having flabellate setae on dorsal surface, secondary rhinaria on Ant.III small sized, roundish, SIPH short cylindrical with sclerites, wing veins of fore wing dark bordered on margin.

Host plant. *Carex* spp.* (Poaceae).

Distribution. Afrotropical, Nearctic, Neotropical and Palearctic region.

Remarks. This is small genus comprising only 2 valid species in the world. All species are associated with *Carex* spp. Apterous viviparous females commonly occur.

Saltusaphis tuberculata Quednau & Lee, 2001 사초혹진딧물 (신칭)

Saltusaphis tuberculata Quednau & Lee, 2001: 214; Quednau, 2010: 83.

Diagnosis. This species is morphologically similar to *S. scirpus* Theobald but can be distinguished by development of dorsal spinal elevations on abdominal tergite I-V.

Description. Alate viviparous female. Color in iife. Not available. *Morphology* (Table S86; Fig. S86). Body eleongated flattened, 2.40-2.52mm long; Head flatend without median protrusion, epicranial suture poorly developed, head dorsum with 0.04-0.05mm pointed setae, antennal tubercle poorly developed; Antenna 6-segmented, antennal surface spiculose, same with body length, Ant.III with 15-22 small sized rounded secondary rhinaria in a row on 4/5 of the segment, longest setae on Ant.III 0.40-0.50 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT 1.45-1.65 times as long as Ant.VIb, Ant.VIb with 0.01-0.02mm of single seta; Rostrum short, barely reaching to fore coxae, URS blunted shaped 0.07mm long with 2 accessory setae, 0.41-0.44 times as long as 2HT; Longest setae on HTB 1.40-1.70 times as long as middle width of HTB, hind first tarsal chaetotaxy 4; Pro-and mesonotum without elevations, mesonotum sometimes with a flabellate seate, metanotum with a pair of elevation; Abdomen spiculose with sclerotic patches, abdominal tergite I-V and VIII with a pair of elevation bearing 1-2 spinal setae, abdominal tergite VIII with 21-23 pointed setae, abdominal margin with dark sclerotic patch with 2-3 marginal setae; SIPH cylindroical, 0.09mm long entirely sclerotized; Cauda knobbed, 0.16-0.18mm long with 16-20 setae; Anal plate bilobed, each lobe with 6-9 setae.

Materials examined. 1 alate viviparous female, Suwon horticultural experiment center, GG, South Korea, 1-10.vi.1970, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 2 alate viviparous females, Suwon horticultural experiment center, GG, South Korea, 21-30.vi.1970, Coll unknown, yellow pan trap, W.H. Paik, NAAS.

Host plant. Unknown.

Biology. Unknown.

Distribution. Korea.

Remarks. This species is described based on alate viviparous female trapped in Korea.

Tribe Thripaphidini Quednau, 1953 총채진딧물족 (신칭)

Type genus: *Thripsaphis* Gillette, 1917: 193.

Synthripaphis Quednau, 1954: 38, 47.

Trichocallis Börner, 1930: 127.

Key to the genera of tribe Thripsaphidini in Korea

1. Empodial setae flabellate, abdominal tergite VIII deeply bipartied .... ***Subsaltusaphis***

- Empodial setae hairlike shape, abdominal tergite VIII rounded, not bipartied. **2**

2. Body setae always pointed, abdominal tergites without sclerotic patch .... ***Allaphis***

- Body setae mostly pointed, rarely mushroom-, flabellate- or star- shaped, abdominal tergites without sclerotic patch .... ***Thripsaphis***

Genus *Allaphis* Mordvilko, 1921 긴총채진딧물속 (신칭)

Type species: *Callaphis caricicola* Mordvilko, 1921: 57.

Heterocallis Quednau, 1966: 422.

Callaphis Mordvilko, 1914: 27.

Diagnosis. This genus is similar to *Thripsaphis* Gillette. However, it can be recognized by having body surface only with pointed setae, ventral sclerites absent, abdominal tergite VIII often without spinal setae.

Host plant. *Carex* spp.* (Poaceae).

Distribution. Australian, Nearctic and Palearctic region.

Remarks. This genus was treated as subgenus of *Thripsaphis* Gillette. However, recently Quednau (2010) re-established this group as distinct genus. This genus comprises 12 species mostly distributed in Neartic region. All species are associated with *Carex* spp. Apterous viviparous female commonly occur.

Allaphis ossiannilssonia (Hille Ris Lambers. 1952) 긴총채진딧물 (신칭)

Thripsaphis ossiannilssoni Hiller is Lambers, 1952: 56.

Trichocallis ossiannilssoni Quednau, 1954: 39, 45; Müller, 1964: 136.

Thripsaphis (*Trichocallis*) *ossiannilssoni* Higuchi, 1972: 77; Hille Ris Lambers, 1974: 140; Quednau & Shaposhnikov, 1988: 1022.

Allaphis ossiannilssoni Quednau, 2010: 73.

Diagnosis. This species can be easily distinguished from congeneric species by having 6-15 seta on abdominal tergite VIII.

Description. Apterous viviparous female. Color in iife. Head dusky pale, compound eye red; Antenna dark; Legs dusky pale, tip of tarsus slightly dark; Thorax and abdomen dusky, abdominal tergite VIII dark. *Morphology* (Table S87; Fig. S87). Body eleongated flattened, 2.09-2.19mm long; Head vertex convexed, head surface dark sclerotized with cribriform wax gland pores, epicranial suture poorly developed, head dorsum with 0.03mm setae, antennal tubercle poorly developed; Antenna 6 segmented, 0.33-0.37 times as long as body length, Ant.I-II faintly imbricated, Ant.III-VI with spicules, Ant.III without secondary rhinaria, longest setae on Ant.III 0.75-1.00 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT short 0.36-0.50 times as long as Ant.VIb, Ant.VIb with 2-3 0.02mm short pointed hairs; Rostrum short not reaching to middle coxae, URS short blunted shaped 0.05-0.06mm long with 2 accessory setae, 0.55-0.67 times as long as 2HT; Longest setae on HTB 0.75-1.00 times as long as middle width of HTB, hind first tarsal chaetotaxy 5; Thorax and abdomen sclerotized with conspicuous spicules, wax gland pores developed, dorsal abdominal setae inconspicuous, abdominal tergite VIII with 12-17 spinal setae, abdominal margin with sclerotic wax gland patch; SIPH small sized poriform 0.01mm; Cauda knobbed, 0.06-0.09mm long with 8-12 setae, cauda knob transversely elliptical; Anal plate broadly rounded with 6-7 short setae.

Description. Alate viviparous female. Color in iife. Head and thorax dark, compound eye red; Antenna dark; Legs dusky; Abdomen pale yellow with dusky sclerotic patch, abdominal tergite VIII dark; Entirely covered with slight wax powder. *Morphology* (Table S87; Fig. S87-2). Body eleongated flattened, 1.70-

1.75mm long; Head vertex convexed, head surface dark sclerotized with cribriform wax gland pores, epicranial suture poorly developed, head dorsum with 0.02-0.03mm setae, antennal tubercle poorly developed; Antenna 6-segmented, 0.47-0.53 times as long as body length, Ant.I-II faintly imbricated, Ant.III-VI with spicules, Ant.III with 7-9 rounded secondary rhinaria in a row on the whole surface, Ant.IV with 1-2 secondary rhinaria, longest setae on Ant.III same with BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT short 0.38-0.46 times as long as Ant.VIb, Ant.VIb with 2-3 short pointed hairs 0.02mm long; Rostrum short not reaching to middle coxae, URS short blunted shaped 0.05-0.06mm long with 2 accessory setae, 0.36-0.46 times as long as 2HT; Longest setae on HTB 1-1.33 times as long as middle width of HTB, hind first tarsal chaetotaxy 5; Thorax dark sclerotized with wax gland pores; Abdomen sclerotized with conspicuous spicules, wax gland pores developed, abdominal tergite VIII with 11-14 spinal setae, abdominal margin with sclerotic wax gland patch; SIPH small sized poriform 0.01mm; Cauda knobbed, 0.06-0.09mm long with 11-13 setae, cauda knob transversely elliptical; Anal plate bilobed, each lobe with 7-9 setae.

Materials examined. 6 apterous viviparous females and 3 alate viviparous females Haesan-ryeong, Hwacheon-gun, GW, South Korea, 30.v.2015, Coll 150530YR-2, on *Carex.* sp., Y. Lee & H. Lee, CALS SNU.

Host plant. Carex spp.* (Poaceae).

Biology. Monoecius holocyclic lifecycle. On between leaves near stem end.

Distribution. Korea, China, and Japan.

Remarks. This species is new to Korea.

Genus *Subsaltusaphis* Mordvilko, 1921 벼룩진딧물속

Type species: *Subsaltusaphis intermedia* Hille Ris Lambers 1921: 103.

Bacillaphis Quednau, 1954: 38.

Diagnosis. This genus is similar to *Iziphya* Nevsky. However, it can be recognized by the mushroom shaped dorsal setae and without black markings on abdominal tergites.

Host plant. *Carex* spp.* (Poaceae).

Distribution. Nearctic, Oriental and Palearctic region.

Remarks. This is second largest genus comprising 13 species under 2 subgenera in the world. *Subsaltusaphis* species are mostly distributed in Europe and Asia. All species are associated with *Carex* spp. (Poaceae). Many species are ant attendece. Apterous viviparous female commonly occur.

***Subsaltusaphis virginica* Baker, 1917 벼룩진딧물**

Saltusaphis virginicus Baker, 1917: 3, 7.

Subsaltusaphis virginica Richards, 1971: 77; Eastop & Hille Ris Lambers, 1976: 385.

Saltusaphis wanica Hottes & Frison, 1931: 265, 266.

Subsaltusaphis saracola Higuchi, 1972: 75.

Subsaltusaphis (*Subsaltusaphis*) *virginica* Remaudière & Remaudière, 1997: 258;

Quednau, 2010: 82.

Diagnosis. This species is closely related to *S. panicae* (Quednau) but can be distinguished by having longer length of antenna, Ant.III faintly spiculose with wax gland pores.

Description. Apterous viviparous female. Color in iife. Not available. Morphology (Table S88; Fig. S88). Body eleongated flattened, 2.43mm long; Head vertex convexed with spicules bearing 0.05mm long and pointed setae, epicranial suture poorly developed, head surface with flabellate setae, antennal tubercle poorly developed; Antenna 6-segmented, long and slender, 0.76 times as long as body length, Antenna with spicules, Ant.III without secondary rhinaria, longest setae on Ant.III 0.33 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT short 0.76 times as long as Ant.VIb, Ant.VIb with 5 hairs 0.01mm long; Rostrum short not reaching to middle coxae, URS short blunted shaped 0.05mm long with 2 accessory setae, 0.38 times as long as 2HT; Longest setae on HTB same as middle width of HTB, hind first tarsal chaetotaxy 4; Thorax and abdomen spiculose over whole surface with flabellate setae, abdominal tergite VIII with 8-13 spinal setae, abdominal margin sclerotic with flabellate setae; SIPH poriform, 0.01mm; Cauda knobbed, 0.12mm long with 12 setae; Anal plate bilobed with 10 setae.

Description. Alate viviparous female. Color in iife. Not available. Morphology (Table S88; Fig. S88-2). Body eleongated flattened, 1.97-2.23mm long; Head vertex convexed, head surface dark sclerotized with spicules, epicranial suture poorly developed, head vertex with 0.02mm setae, antennal tubercle poorly developed; Antenna 6 segmented, 0.54 times as long as body length, Antenna spicules, Ant.III with 8 rounded secondary rhinaria in a row on the whole surface, Ant.IV without secondary rhinaria, longest setae on Ant.III 0.33 times as long as BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT short 0.73 times as long as Ant.VIb, Ant.VIb with 3 short pointed hairs 0.01mm long; Rostrum short not reaching to middle coxae, URS short blunted shaped 0.05-0.07mm long with 2 accessory setae, 0.38-0.53 times as long as 2HT; Longest setae on HTB 0.8 times as long as middle width of HTB, hind first tarsal chaetotaxy 4-5; Thorax dark sclerotized with spicules; Abdomen sclerotized with conspicuous spicules bearing flabellate setae; SIPH small sized 0.01mm long; Cauda knobbed, 0.09-1.00mm long with 12-14 setae; Anal plate bilobed, each lobe with 6-8 setae.

Materials examined. 2 alate viviparous females, Bucheon, GG, South Korea, 1-10.vi.1970, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 alate viviparous female, Goyang-si, GG, South Korea, 11-20.vi.1970, Coll unknown, yellow pan trap, W.H. Paik, NAAS; 1 apterous viviparous female, Cedar lake, Ontario, Canada, 15.vii.1963, Coll unknown, on Carex sp., W.R. Richards, CNC.

Host plant. *Carex* spp.* (Poaceae).

Biology. Monoecius holocyclic lifecycle. On between leaves near stem end.

Distribution. Korea, Japan, Canada and USA.

Genus *Thripsaphis* Gillette, 1917 총채진딧물속 (신칭)

Type species: *Brachycolus ballii* Gillette, 1908: 193.

= *Thripsahis ballii ballii* (Gillette, 1908)

Synthripaphis Quednau, 1954: 38, 47.

Trichocallis Börner, 1930: 127.

Diagnosis. This genus is morphologically similar to *Allaphis* Mordvilko. However, it can be distinguished by having flabellate and pointed setae on the head and body, abdominal tergites with sclerotic patch and abdominal tergite VIII not modified.

Host plant. *Carex* spp.* (Poaceae).

Distribution. Nearctic and Palearctic region.

Remarks. This is well known genus including 8 species under 3 subgenera. Quednau (2010) reviewed the world fauna of this genus. All species occur on *Carex* spp. Many species are ant attendece. Apterous viviparous female commonly occur.

Thripsaphis ballii caspitosae Ossiannilsson, 1954 제주총채진딧물 (신칭)

Thripsaphis caspitosae Ossiannilsson, 1954: 118; Richards, 1917: 84.

Thripsaphis (*Thripsaphis*) *caspitosae* Quednau. 1997: 259.

Thripsaphis (*Thripsaphis*) *ballii caspitosae* Quednau. 2010: 77.

Diagnosis. This species is closely related to *T. balli balli* but can be distinguished by having longer anttenal setae, less sclerotized abdominal tergites and pale legs.

Description. Apterous viviparous female. Color in iife. Head dusky pale brown, compound eye dark red; Ant.I-II concolorus with head, Ant.III-VI dark; Legs dusky pale; Thorax and abdomen pale with dusky sclerotic patch; Entirely covered with slight wax powder. Morphology (Table S89; Fig. S89). Body narrow eleongated flattened, 1.49-1.89mm long; Head vertex convexed bearing 0.03-0.06mm pointed setae, epicranial suture poorly developed, head surface spiculose, antennal tubercle poorly developed; Antenna 6 segmented, 0.39-0.50 times as long as body length, Antenna I-II faintly spiculose, Ant.III-VI spiculose, Ant.III without secondary rhinaria, longest setae on Ant.III same with BDAnt.III, Ant.V and VI with ciliated rounded primary rhinaria each, PT short 0.50-0.70 times as long as Ant.VIb, Ant.VIb with 4 hairs 0.02-0.03mm long; Rostrum short not reaching to middle coxae, URS short blunted shaped 0.05-0.06mm long with 2 accessory setae, 0.36-0.55 times as long as 2HT; Longest setae on HTB 1.33 times as long as middle width of HTB, hind first tarsal chaetotaxy 3; Thorax and abdomen spiculose over whole surface with short and pointed setae, abdominal tergite VIII with 16-21 spinal setae, abdominal margin sclerotized; SIPH poriform, 0.01mm; Cauda knobbed, 0.07-0.09mm long with 10-12 setae; Anal plate bilobed with 5-7 setae.

Materials examined. 11 apterous viviparous female, Is. Woodo, Bukjeju-gun, JJ, South Korea, 19.iv.2000, Coll 000417SH-27, on *Carex* sp., S. Lee, NAAS; 8 apterous viviparous females, Mt. Songaksan, Namjeju-gun, Seoguipoi-si, JJ, South Korea, 24.x.2000, Coll 001023-SH27, on unknown host, S. Lee, NAAS; 17 apterous viviparous females, Is. Woodo, Bukjeju-gun, JJ, South Korea, 1.viii.2014, Coll 140801YR-5, on *Carex* sp., CALS SNU; 20 apterous viviparous females, Wolpyeong-dong, Jeju-si, JJ, South Korea, 29.iv.2016, Coll 1604029YR-29, on *Carex* sp., Y. Lee, CALS SNU.

Host plant. *Carex* spp.* (Poaceae).

Biology. Monoecius holocyclic lifecycle. Between leaves near stem end.

Distribution. Korea, Finland and Canada.

Remarks. This species is only collected in Is. Jeju in Korea. This species was originally described from Canada as distinct species. Later, Quednau (2010) treated this species as one of the subspecies of *T. balli*.

PART II. DNA barcoding on Calaphidinae *s.s.* (Hemiptera: Aphididae): cryptic diversity identificaiton

Abstract

Aphids are a species rich group comprising many important pests. However, species identification can be very difficult for aphids due to their morphological ambiguity. DNA barcoding has been widely adopted for rapid and reliable species identification as well as cryptic species detection. In this study, cryptic diversity in the subfamily Calaphidinae (Hemiptera: Aphididae) was investigated based on 899 sequences of cytochrome c oxidase I (*COI*) for 115 morphospecies (78 species collected in this study and sequences of 73 species downloaded from Genbank). Among these 115 morphospecies, DNA barcoding results of 90 (78.3%) species were identical to results of morphological identification. However, 25 (21.7%) morphospecies showed discrepancies between DNA barcoding and traditional taxonomy. Among these 25 discordances, a total of 15 cryptic species were identified from 12 morphospecies. I also found three morphologically distinct species pairs that sharing DNA barcoding. Based on molecular operational taxonomic unit (MOTU) estimation, species delimitation threshold value was discussed for these taxa. This results confirm that Calaphidinae has high cryptic diversity even though aphids are relatively well-studied.

Keywords: aphids, barcode sharing, Calaphidini, *COI*, cryptic species, Panaphidini

2.1. Introduction

Detecting cryptic species is essential for precise species diversity estimation (Bickford et al., 2007). With the availability of DNA barcoding methods, recognition of cryptic species has been increased over the past decades (Bickford et al., 2007). To date, DNA sequences of approximately 10% of all described species (ca. 160,000) are deposited in open access databases such as Barcode of Life Data Systems (BOLD) and the National Center for Biotechnology Information (NCBI) (Ratnasingham & Hebert, 2007; Federhen, 2012). More recently, some researchers have suggested that DNA-sequenced-based taxonomic description alone is not only enough for species identification but also can be used as an alternative to classical taxonomy (Cook et al., 2010). Indeed, DNA barcoding has been contributed to resolve morphological ambiguity in various taxa (Hebert et al., 2004a; Stuart et al., 2006; Lee et al., 2011; Saitoh et al., 2015; Han et al., 2016) with identification accuracy rate of 97% (Hebert et al., 2004b; Hajibabaei et al., 2006 ; Hajibabaei et al., 2007; Foottit et al., 2008). Therefore, DNA barcoding enables the detection of cryptic species and reassessment of species diversity.

Aphids are small and soft-bodied plant sap sucking insects. Over 5,000 of aphid species have been described worldwide (Favret, 2017), including many important pests in agriculture, forestry, and species of quarantine importance (Eastop, 1977; Blackman & Eastop, 2000; Teulon & Stufkens, 2002 Foottit et al., 2006; Messing et al., 2007). However, the lack of taxonomically informative characters and morphological plasticity of aphids make species recognition challenging (Hille Ris Lambers, 1966). Notably, in the complex life cycle of aphids, multiple morphs within one species can occur due to seasonal changes (Miyazaki, 1987). Numerous biotic factors such as host plant relationships (Wool & Hales, 1997), natural enemies (Weisser et al., 1999), ant attendance (Yao, 2012), maternal effects Hardie & Lees, 2013), endosymbionts (Tsuchida et al., 2010), and infectious microorganisms (Johnson et al., 2003) can affect intraspecific plasticity of aphids. Various abiotic factors, such as climate, temperature, and photoperiod (Blackman & Spence, 1994) also have effects on their intraspecific plasticity. Conversely, extremely similar or even morphologically indistinguishable species can occur among aphids (Foottit et al., 2009; Massimino Cocuzza & Cavalieri, 2014; Lee et al., 2015). The utility of DNA barcoding for aphid species identification has been demonstrated at family level (Foottit et al., 2008; Lee et al., 2011; Foottit et al., 2009). It is also useful for some subfamilies such as Eriosomatinae (Lee & Akimoto, 2015), Greenideinae (Liu et al., 2013), and Lachninae (Chen et al., 2012). According to these studies, DNA barcoding can provide rapid and reliable identification results for aphids. However, no assessment has been attempted for the subfamily Calaphidinae.

The subfamily Calaphidinae (Hemiptera: Aphididae) is the second largest subfamily in family Aphididae. About 398 valid species belonging to 59 genera have been described in the world (Quednau, 1999; Quednau, 2003; Favret, 2017). Most calaphidine aphids feed on woody angiosperms belonging to 16 plant families such as Betulaceae, Fagaceae, Juglandaceae, Lythraceae, Myricaceae, and Ulmaceae although some species feed on herbaceous plants belonging to

Fabaceae and Poaceae (Quednau, 2003; Blackman & Eastop, 2017). Many aphid species belonging to this subfamily are economically important pests, causing injury and transmitting viral diseases to cultivated plants such as leguminous crops, fruit, and landscape trees (Nebreda et al., 2004; Hbert & Mizell 2008). For example, *Therioaphis trifolii* (Monell, 1882), *Melanocallis caryefoliae* (Davis, 1910) and *Monellia caryella* (Fitch, 1855) are notorious aphid pest have caused large agricultural economic losses (Stern et al., 1959; Cottrell et al., 2010; Wood et al., 1997). Some aphid pest, such as *Sarucallis kahawaluokalani* (Kirkaldy, 1907), *Shivaphis celti* Das, 1918, and *Tinocallis* spp. have been dispersed from their geographic origins to different continents (Halbert & Pike, 1990; Halbert & Choate, 1998; Foottit et al., 2006; Kondo & Cortés, 2014). However, assessing calaphidine species can be difficult and time consuming since their considerable morphological variation based on seasonal changes and various biotic factors (Quednau, 2003; Yao, 2012). The application of DNA barcoding would assist in rapid and accurate identification of species in this subfamily. It can also aid the detection of cryptic diversity.

In this study, the first comprehensive assessment of DNA barcodes for the subfamily Calaphidinae was provided. A total of 501 *Cytochrome oxidase I* (*COI*) sequences of 78 morphospecies collected in Korea and other countries from 2001 to 2015 were analyzed. The objectives of this study were i) to clarify delimiting species boundaries in morphologically ambiguous taxa, ii) to test the effectiveness of DNA barcoding in this taxa, and ultimately iii) to detect hidden species diversity.

2.2. Materials and Methods

2.2.1. Taxon sampling

A total of 501 aphid individuals of 78 species were collected in Asia: Korea (382 specimens of 52 species), China (20 specimens of 8 species), Japan (23 specimens of 8 species), and Laos (2 specimens of 1 species); Europe: Czech Republic (15 specimens of 7 species), Poland (16 specimens of 7 species), and UK (5 specimens of 1 species); North America: USA (29 specimens of 14 species); and Oceania: New Zealand (9 specimens of 4 species) from 2001 to 2015. Each specimen was preserved in 95–99% ethanol at -20°C for genomic DNA extraction.

2.2.2. Species identification

501 individuals were mounted in Canada balsam following the method of Blackman & Eastop (2000) and Martin (1983). Measurements for each specimen were taken from digital images by using image analysis software (Active measure ver. 3.0.3 from Mitani Co. Ltd, Japan). Digital images were taken by a digital camera attached to a microscope (Leica 400B, Leica Microsystems, Germany). All slide specimens were deposited in the College of Agriculture and Life sciences, Seoul National University (CALS SNU), the Republic of Korea.

2.2.3. DNA extraction and DNA barcoding

Genomic DNA was extracted from each sample selected from each colony by using the DNeasy Blood & Tissue kit (Qiagen, Dusseldorf, Germany) according to the modified manufacturer's protocols. To confirm morphological features, I used a nondestructive method: each whole-bodied specimen was put into a mixture of 90μl of ATL buffer and 10 μl of proteinase K incubated without pulverization. After 24 h incubation, 90μl AL buffer was added and incubated for another 10 min. The solution was gently pipetted into a mini spin column leaving the cuticle of the specimen which was slide mounted.

A 658 bp of *COI* gene region, generally called as 'barcoding region' was amplified using a universal primer set: LCO1490 5'-GGTCAACAAATCATAAAGATATTGG-3' and HCO2198 5'-TAAACTTCAGGGTGACCAAAAAATCA-3' (Folmer et al., 1994). Polymerase chain reaction (PCR) was conducted with AccuPower PCR PreMix (Bioneer, Daejeon, Korea) in 20 ml reaction mixtures under the following conditions: initial denaturation at 94°C for 3 min; followed by 35 cycles at 94°C for 30s, an annealing temperature of 45.2°C for 30s, an extension at 72°C for 1min; and the final extension at 72°C for 5min. All PCR products were assessed 1.5% agarose gel electrophoresis. Successfully amplified samples were purified using a QIAquick PCR purification kit (Qiagen, Inc.), and then sequenced directly using an automated sequencer (ABI PrismH 3730 XL DNA Analyzer) at Macrogen Inc. (Seoul, Korea).

2.2.4. Molecular analyses

All sequences to be analyzed were initially assembled and examined using Seqman pro ver. 7.1.0 (DNA star, Inc., Madison, Wisconsin, USA). Poor quality sequences with ambiguous peaks were removed. I used the molecular identification criteria of putative orthologues and paralogues according to Moulton et al. (2010) and Fontaneto et al. (2015), to prevent misleading by nuclear mitochondrial pseudogenes (Numts) and heteroplasmy. A total of 501 *COI* sequences of 78 species including previously unknown sequences of 42 species were newly generated for the molecular analyses. Additionally, 398 *COI* sequences of 73 species were downloaded from Genbank using keyword '*COI*' and 'Calaphidinae'. As a result, the final dataset consisted of 899 sequences of 115 species.

These data was aligned using online utility MAFFT ver. 7 alignment package (Katoh & Standley, 2013) and MEGA 6 (Tamura et al., 2013). In this step, I removed uncertain anterior and posterior regions were removed. Fnally, ≥ 546 bp was used for analyses. For the aligned dataset, a neighbor-joining analysis was conducted using MEGA 6 based on Kimura-2-Parameter (K2P) model (Kimura, 1980), the best for species level analysis, particularly for those with low distances (Hebert et al., 2003). Intra- and inter-specific distances in different taxonomic levels were calculated using pairwise distance method based on the K2P model (Kimura, 1980) using MEGA 6.

To infer species delimitation criteria based on a partial *COI* gene in this subfamily, I performed molecular operational taxonomic units (MOTUs) estimation by using two effective tools to delimit molecular species. First, Automatic Barcode Gap Discovery (ABGD) analysis was conducted to automatically delimit sequences into hypothetical molecular species (Puillandre et al., 2012) (available at http://wwwabi.snv.jussieu.fr/public/abgd) by contrasting inter- and intra-specific distances. Standard settings were used with two values of relative gap width (*X*= 1 and *X*=1.5) based on Kimura K80 model. Additionally, Bayesian Poisson Tree Processes (bPTP) analysis as implemented on the Exelixis Lab web-server (http://species.h-its.org/ptp/) was performed. This method delimits species based on the phylogenetic species concept (Zhang wet al., 2013). Compared to the generalized mixed Yule coalescent (GMYC) model, bPTP model is a more robust and simpler method (Tang et al., 2014). The required rooted phylogenetic input tree was drawn using RAxML (Stamatakis, 2006) with GTR+G+I substitution model.

2.3. Results

2.3.1. Genetic variation of morphospecies

A total of 501 *COI* sequences (≥ 546 bp) from 78 morphospecies belonging to 36 genera of four subtribes, Calaphidina, Monaphidina, Myzocallidina, and Panaphidina were newly generated in this study. All sequences are deposited in Genbank (KY306805-KY307305). Results of genetic divergence at different taxonomic levels are summarized in Table 1.

The overall mean distance was 13.2% for the final dataset of 899 sequences of 115 species. The mean interspecific distance ranged from 4.19% to 13.3% at genus level. The mean genetic distance between genera ranged from 11.92% to 14.51% at subtribe level.

Intraspecific genetic distance was calculated for the 100 of 115 morphospecies. For the remaining 15 species, intraspecific distances could not be calculated because there was only one individual representing each species. The mean intraspecific distance ranged from 0 to 6.0% in each species. Among these 100 morphospecies, 78 species showed very low to moderate genetic divergences (below 1.5%, Fig. 2.1). Another 4 species showed ambiguous intraspecific distances ranging from 1.7% to 1.9% (Fig. 2.1). However, the remaining 18 species showed relatively high intraspecific distances ranging from 2.9% to 16.6 % (Fig. 2.1, Table 2.2). Such a high level of intraspecific distance indicate that there might be potential cryptic species and/or misidentified sequences in these of 18 species (Table 2.2).

2.3.2. MOTUs estimation

The number of MOTUs determined by ABGD differed slightly depending on the value of the relative gap width (Fig. 2.2). When *p* value was set at 0.0129, the number of MOTUs was 133 at relative gap width *X* = 1 or *X* = 1.5 (Fig. 2.2). Based on ABGD result, 16 species were divided into 2–4 inner-groups in each species group (Fig. 2.3). Three morphologically distinct species pairs: i) *Pterocallis alnijaponicae* and *P. nigrostriata*, ii) *Tiliaphis pseudoshinae* and *T. shinae* and iii) *Tuberculatus* (*Orientuberculoides*) *capitatus* and *T.* (*O.*) *fangi* were clustered together as a single MOTU, respectively (Table 3). The bPTP model recognized a total of 136 MOTUs except for outgroup based on the maximum likelihood method. Among 115 morphospecies, 19 species were subdivided into 2–4 inner-groups in each species group (Fig. 2.3). This result was similar not only based on the number of MOTUs, but also based on MOTU compositions obtained from ABGD (Fig. 2.3). Overall, the bPTP model tended to be more sensitive to MOTU delimitation. ABGD and bPTP resulted in different estimates for 8 morphospecies (Fig. 2.3). For example, 4 morphospecies, *Takecallis arundinariae*, *Tuberculatus* (*Nippocallis*) *kuricola*, *Tuberculatus* (*Arakawana*) *stigmatus*, and *Myzocallis* (*Lineomyzocallis*) *bellus*, were subdivided into two groups each in the bPTP results. However, no subdivision was detected for these 4 species based on ABGD results (Fig. 2.3). On the contrary, *Tiliaphis shinae* and *T*. *pseudoshinae* pair was clustered together as a single MOTU in the bPTP model (Fig. 2.3).

2.3.3. Neighbor joining analysis: case of species delimitation

The Neighbor joining tree (NJ tree) was derived for these 899 *COI* sequences of the 115 species (Fig. 2.4). For majority of cases, sequence clusters in the NJ tree showed high congruence with morphological identification results. Practically, 90 species (78.3%) of all species could be clearly identified by *COI* sequence. However, for the remaining 25 species (21.7%), discrepancies between morphology and barcode based identification were detected. DNA barcoding analyses revealed the following: i) 15 cryptic species from 12 morphospecies, ii) six possible cryptic or potential misidentified sequences in the Genbank, iii) three morphologically distinct species pairs that sharing a single MOTU, and iv) four species with ambiguous inter- and intra-specific distances. Detailed results for these four cases are described as follows.

Case I: Discovering cryptic species.

A total of 15 cryptic species from 12 morphospecies were found based on original description and other information of each morphospecies such as host plant association and distributional information. Because in any case, it is impossible to identify DNA barcode for type materials. For each case, comparison between original and cryptic species was discussed.

I.1. *Calaphis* spp. A total of 66 individuals of 5 species belonging to genus *Calaphis* were analyzed in this study. DNA barcoding detected 2 cryptic species in *Calaphis flava* (Fig. 2.5). Between group 1 and group 2, intergroup divergence was 2.9–4.0% (Fig. 2.5). Group 3 consisted of 7 Canadian and 1 American individual was distinct from group 1 and group 2 with 4.5–6.1% of genetic divergence (Fig. 2.5). This species was originally distributed throughout Europe and East Asia. Now it is regarded as a widespread species found in South Africa, Australia, and North America. Thus, further studies are needed to compare European individuals of *C. flava* in the future study to investigate whether this species is a real cosmopolitan species or a species complex.

I.2. *Eucallipterus tiliae*. A total of 23 individuals of *Eucallipterus tiliae* were collected from Europe: Czech Republic, France, Italy, and Poland, North America: Canada and USA; and Oceania: New Zealand. ABGD, bPTP (Fig. 2.3) and NJ tree revealed 1 cryptic species (group 2) of *E. tiliae* with about 2.9% of intergroup genetic divergence (Fig. 2.6). Morphologically, individuals in group 1 and 2 are very similar. However, cryptic species (group 2) is distinguishable from typical *E. tiliae* (group 1) by having longer length of 3rd–5th antennal segment and 2nd tarsal segment (Fig. 2.7). In genus *Eucallipterus*, only two species have been described in the world. *E. tiliae* is a common species widely distributed throughout Europe across central Asia, and South-Africa. It has also been introduced into North America and New Zealand (Quednau, 2003). My results suggest that this species might be a species complex rather than a cosmopolitan species.

I.3. *Mesocallis* spp. ABGD and bPTP analyses on 45 individuals of four Korean species of *Mesocallis* disclosed one cryptic species in *M. corylicola* (Figs 3 and 6). *M. corylicola* (group 1) and cryptic species (group 2) showed 5.5–7.1% of genetic distance (Fig. 2.8). In contrast to such a high level of genetic distance, the cryptic species and *M. corylicola* are superficially similar in morphology. Compared to *M. corylicola*, the cryptic species has a shorter siphunculi and longer length of ultimate rostral segment (Fig. 2.9). Host plant preference appeared to differ between the two species. Most *M. corylicola* was collected on *Corylus sieboldiana* while most cryptic species were collected on *C. heterophylla*. According to the original description, original species was collected on *Corylus sieboldiana* (Higuchi, 1972). Thus, the two groups have different *COI* sequences, host plant preference, and morphology.

I.4. *Monaphis antennata*. Eight individuals of *Monaphis antennata* collected from Canada, Korea, and Poland were analyzed with ABGD, bPTP (Fig. 2.3), and NJ tree (Fig. 2.10). Korean individuals formed a group (group 1) distinct from Polish and Canadian individuals with 2.4–2.9% intergroup genetic divergence (Fig. 2.10). *Monaphis* is a monotypic genus originally described from Europe. This species lives solitarily on *Betula* spp. In Korea, *Monaphis* is extremely rare. It has only been collected on *Betula schmidtii*. In Europe and Japan, it has been collected on *B. pendula* (Hopkins & Dixon, 2000; Borowiak-Sobkowiak & Wilkaniec, 2010) *B. maximowicziana* and *B. platyphylla* var. *japonica* (Higuchi, 1972). Although I could not perform morphological comparisons on subgroups, the Korean cluster seems to be a distinct species based on the molecular divergence level.

I.5. *Takecallis* spp. I analyzed 58 individuals of five *Takecallis* spp. collected from East Asia: China, Japan, and Korea, Europe: Czech Republic, France, and Italy, and North America: Canada and USA. According to both ABGD and bPTP analyses, *T. arundicolens* were separated into three groups (Figs 2.3 and 2.11). Genetic divergence between group 1 and group 2+3 ranged from 7.6% to 10.4%. Genetic divergence between group 2 and group 3 was 2.5%. In each group, morphological differences were only detected between alatoid nymphs. Alatoid nymphs in group 1 could be distinguished by a dark colored cauda with short dorsal abdominal setae (Fig. 2.12). Group 2 and group 3 shared similar morphology. However, group 3 could be distinguished from group 2 by shorter siphunculi with long filiform setae on the body (Fig. 2.12). *T. arundicolens* is one of common bamboo feeding species. Originally, this species was described from East Asia. It has been introduced into Europe and North America. My results indicate that European populations (group 2) might be species distinct from Asian species (group 1 and group 3).

I.6. *Tinocallis* spp. A total of 48 individuals of nine *Tinocallis* spp. collected from East Asia: Korea and North America: Canada and USA were analyzed. Both ABGD and bPTP analyses recognized two subgroups (group 1 and group 2) among 22 individuals of *T. zelkowae* collected from Korea (Fig. 2.3). These groups showed genetic divergence of 5.5–6.5% (Fig. 2.13). Morphologically, individuals of group 1 have longer ultimate rostral segments than those of group 2 with pigmented dorsal abdominal elevations (Fig. 2.14). Group 1 is relatively rare. It was only collected on native *Zelkova serrata* (var. *latifolia*) growing in Korean mountain areas. *T. zelkowae* of the group 2 is one of the most common species dwelling on *Zelkova* trees in urban area (mostly the Japanese species *Zelkova serrata* (var. *japonica*)). Results of this study indicate that group 1 might be species separated from group 2 with different host plant association.

I.7. *Tuberculatus* spp. In genus *Tuberculatus*, a total of seven cryptic species were discovered. Detailed results for each subgenus are provided as follows.

I.7.1. Subgenus *Acanthocallis* spp. A total of 69 individuals of two species belonging to the subgenus *Acanthocallis* collected from Japan and Korea were analyzed. Of 21 Korean individuals of *Tuberculatus* (*Acanthocallis*) *quercicola*, 16 individuals formed group 3, distinct from Japanese and remaining 5 Korean individuals of *T*. (*A*.) *quercicola* (group 2) with about 5.2% of intergroup genetic divergence (Figs 2.3 and 2.15). Individuals of group 3 were different from group 2 only by having shorter setae on 3rd antennal segment with more setae on 4th–5th antennal segments (Fig. 2.16). Watanabe et al. (2015) have reported that *Acanthocallis* species tend to have high host specificity. It has been shown that Japanese *T*. (*A*.) *quercicola* and *T*. (*A*.) *macrotuberculatus* have distinct host plant associations with *Quercus mongolica* spp. *crispula* and *Q*. *dentate*, respectively (Watanabe et al., 2015). Likewise, three Korean species: *T*. (*A*.) *quercicola* in group 2, *T*. (*A*.) *macrotuberculatus* in group 1, and cryptic species in group 3 showed distinct host plant association with *Q*. *mongolica*, *Q*. *dentate*, and *Q*. *aliena*, respectively. Therefore, different host associations between species can be used for species identification in this group.

I.7.2. Subgenus *Acanthotuberculatus* spp. A total of 26 individuals of four species belonging to subgenus *Acanthotuberculatus* were analyzed. As shown in Fig. 2.3 and Fig. 2.17, 14 specimens of *Tuberculatus* (*Acanthotuberculatus*) *indicus* were split into two subgroups with intergroup genetic divergence ranging from 2.4% to 2.9%. Nine specimens collected from Korea were identical to undescribed species *Tuberculatus* sp. E (Yao, unpublished, *COI* sequence Genbank accession no. AB861448). *Tuberculatus* (*A*.) *japonicus* and undescribed species, *Tuberculatus* sp. IY-C (Yao, 2011), showed inter-specific distance of 4.5% to 5.1%. No morphological comparisons was undertaken.

I.7.3. Subgenus *Orientuberculoides* spp. DNA barcoding uncovered five cryptic species among 86 specimens of seven species in subgenus *Orientuberculoides* (Fig. 2.3). *Tuberculatus* (*Orientuberculoides*) *higuchii* was subdivided into four subgroups, including previously detected species *T*. (*O*.) *higuchii* A (group 1) and *T*. (*O*.) *higuchii* B (group 3) (Yao, 2011) and two newly detected subgroups (Fig. 2.18). For convenience, these newly detected subgroups were named as *T*. (*O*.) *higuchii* C (group 2) and *T*. (*O*.) *higuchii* D (group 4). Among those four subgroups, intergroup genetic divergence of 2.8% to 4.1% was observed (Fig. 2.18). *T*. (*O*.) *higuchii* A has shorter 2nd–4th antennal segments in comparison with other subgroups (Fig. 2.19). *T*. (*O*.) *higuchii* B is distinct from other subgroups by having shorter siphunculi (Fig. 2.19). *T*. (*O*.) *higuchii* C has slightly longer second tarsal segments and cauda (Fig. 2.19). *T*. (*O*.) *higuchii* D is distinguished from others by having more secondary sensoria on the 3rd antennal segment (Fig. 2.19).

Fourteen specimens of *Tuberculatus* (*Orientuberculoides*) *kashiwae* collected from Japan and Korea were divided into two subgroups with intergroup genetic divergence of 5.1% to 5.5% (Fig. 2.18), confirming earlier suggestion by Yao (2011). All Korean specimens were clustered together with *T*. (*O*.) *kashiwae* B (Yao, 2011). Only two sequences from Japan formed group 1 (*T*. (*O*.) *kashiwae* A).

A total of 25 individuals of *Tuberculatus* (*Orientuberculoides*) *yokoyamai* collected from Japan and Korea were analyzed. Results are shown in Fig. 2.12. ABGD and bPTP analyses detected two cryptic species within *T*. (*O*.) *yokoyamai*, showing genetic divergence of 3.5% to 4.1% (Fig. 2.18). Thirteen specimens collected from Japan and Korea formed group 1 together with *Tuberculatus* sp.

D Yao (unpublished, *COI* sequence Genbank accession no. AB861455). Morphologically, group 1 was distinguished from group 2 by having longer length of 5th antennal segment, siphunculi, and cauda (Fig. 2.20). There was no host plant difference between the two groups.

I.7.4. Subgenus *Tuberculoides* spp. *COI* sequences of 19 specimens of three species in the subgenus *Tuberculoides* revealed two groups within *Tuberculatus* (*Tuberculoides*) *annulatus* (Figs 2.3 and 2.21) with genetic divergence of 5.1–5.5%. All 10 individuals of group 1 were collected from Europe: France, Poland, and UK. Group 2 comprised of 7 North American specimens, 3 New Zealand specimens, and one French specimen. One French specimen in group 2 has been regarded as an outlier in a previous study of Coeur d'Acier et al. (2014). However, this haplotype was present in North America and New Zealand. Morphological features of the two subgroups (group 1 and group 2) of *T.* (*T.*) *annulatus* were compared. Group 2 is distinguishable from group 1 by shorter antennae and smaller cauda knob with longer setae (Fig. 2.22). Based on molecular and morphological differences, group 1 and group 2 might be distinct species. It has been widely assumed that *T.* (*T.*) *annulatus* is introduced into North America, South America, Australia, and New Zealand from Europe (Blackman & Eastop, 2017). However, such assumption need to be examined in future studies.

Case II: Discovering possible cryptic or misidentified sequences in NCBI.

A total of 398 *COI* sequences of 73 species were downloaded from Genbank and used in this study. The following statements are only suggestions since specimen morphology could not be examined in this study.

II.1. *Myzocallis* spp. In genus *Myzocallis*, a total of three possible discrepancies compared to current species concepts were identified. Detailed results of each subgenus are described as follows.

II.**1.1. Subgenus *Myzocallis* spp.** I analyzed 26 sequences of four species belonging to subgenus *Myzocallis* collected from Europe: Czech Republic, France, Italy, and Poland; North America: Canada and USA; and Oceania: New Zealand. ABGD and bPTP analyses revealed two subgroups in *Myzocallis* (*Myzocallis*) *coryli*. Group 1 and group 2 showed intergroup genetic divergence of 2.9–3.4% (Fig. 2.23). Group 1 of *M.* (*M.*) *coryli* formed a sister group of *M.* (*M.*) *carpini* with genetic divergence of 2.7–3.1%. Group 1 mostly comprised of North American specimens except for one French specimen (Genabank accession no. KF639545) while all specimens of group 2 were from France. Coeur d'Acier et al. (2014) have reported that *M.* (*M.*) *coryli* show exceptionally high intraspecific divergence due to the outlier. However, the outlier was the most common haplotype of *M.* (*M.*) *coryli* in my dataset. *M.* (*M.*) *coryli* is widely known as a cosmopolitan species. However, my results suggested that this species might be a species complex.

Myzocallis (*Myzocallis*) *boerneri* specimens collected from New Zealand and Italy showed genetic divergence of 8.4% (Fig. 2.23). This species was originally described from Europe and introduced into New Zealand (Rohitha, 1982). Assuming species identification of Italian *M.* (*M.*) *boerneri* is correct. My results suggested that European and New Zealand populations are distinct species.

II.1.2. Subgenus *Neosymydobius* spp. *COI* sequences of two *Neosymydobius* species, *Myzocallis* (*Neosymydobius*) *asclepiadis* and *M.* (*N.*) *punctata*, revealed possible misidentified sequences of *M*. (*N*.) *punctata* (Fig. 2.24). As a result of ABGD and bPTP analyses, *M*. (*N*.) *punctata* was subdivided into two subgroups (Fig. 2.3). Four sequences of *M*. (*N*.) *punctata* (Genbank accession no. EU701771, KR030925, KR043984, and KR037948) were completely identical to those of *M*. (*N*.) *asclepiadis* rather than to *M*. (*N*.) *punctata* with 100% support value (Fig. 2.24). My results suggested that 4 individuals (Genbank accession no. EU701771, KR030925, KR043984, and KR037948) of *M*. (*N*.) *punctata* might be misidentification of *M*. (*N*.) *asclepiadis*.

II.3. *Shivaphis* spp. Among 22 specimens of five *Shivaphis* spp., 7 individuals of *Shivaphis celti* showed extremely high levels of intraspecific distance (16.1% to 16.6%) due to a single sequence (Genbank accession no. JQ920934) (Fig. 2.25). Such a high intraspecific distance suggests that this specimen might be a misidentification or a cryptic species. Subsequent morphological re-examination of the voucher specimen for this sequence (Genbank accession no. JQ920934) is needed.

II.4. *Tiliaphis* spp. A total of 20 specimens of four *Tiliaphis* species were analyzed. I found a possible misidentified sequence which was identified as *Tiliaphis shinae* (Genbank accession no. GU978821) (Fig. 2.26). Subsequently, I re-examined the voucher specimen of this sequence and found that this specimen was in fact *T. coreana*.

II.5. *Tuberculatus* (*Tuberculatus*) *querceus*. Three sequences of *Tuberculatus querceus* were divided into two subgroups with divergence of 8.2% (Fig. 2.27). This species is distributed through Europe to South-western Asia. It is also introduced into Canada (Foottit et al., 2009; Blackman & Eastop, 2017).

However, my results suggested that European and Canadian specimens might be distinct species.

Case III: Low genetic distances between morphologically distinct species.

III.1. *Pterocallis alnijaponicae* and *P. nigrostriata*. Morphologically, *Pterocallis alnijaponicae* and *P. nigrostriata* are easily distinguishable species (Fig. 2.28). As shown in Fig. 2.19, *P. nigrostriata* has 5–6 long and conspicuous dorsal abdominal tubercles and forewing with unique marginal patch while *P. alnijaponicae* has 3–4 short dorsal abdominal tubercles and forewing without marginal patches. Unexpectedly, low genetic divergence (0.5%) between *P. alnijaponicae* and *P. nigrostriata* was found (Fig. 2.29). ABGD and bPTP analyses also supported these results by combining *P. alnijaponicae* and *P. nigrostriata* as a single MOTU (Fig. 2.3). Such discrepancies between morphological and DNA barcoding results raise a question about the validity of these species.

III.2. *Tiliaphis pseudoshinae* and *T. shinae*. *Tiliaphis pseudoshinae* and *T. shinae* are morphologically similar. However, *T. pseudoshinae* can be distinguished from *T. shinae* by having longer ultimate rostral segment, shorter antenna, and less secondary sensoria on the 3rd antennal segment (Fig. 2.30). Between these two species, sequence divergence of 2.1% to 2.5% was observed (Fig. 2.26). Based on ABGD analysis, *T. pseudoshinae* and *T. shinae* were separated into distinct MOTUs. However, bPTP analysis grouped these two species as a single MOTU (Fig. 2.3). Thus, comparing more specimens with multiple generic markers is needed for better delimitation of these species.

III.3. *Tuberculatus* (*Orientuberculoides*) *capitatus* and *T.* (*O.*) *fangi*. Four individuals of *Tuberculatus* (*Orientuberculoides*) *capitatus* and nine individuals of *T.* (*O.*) *fangi* were analyzed. *T.* (*O.*) *capitatus* and to *T.* (*O.*) *fangi* can be distinguished by having different shapes and lengths of setae (Fig. 2.31). However, their genetic divergence was only 0.5% to 1.5% (Fig. 2.18). In fact, different shapes, arrangement, and lengths of hairs are often can be critical characteristics for aphid species delimitation. A review of the variations within and between these species is still required.

Case IV: Ambiguous genetic distances.

IV.1. *Myzocallis* (*Lineomyzocallis*) *bellus*. In this study, six individuals of three species in subgenus *Lineomyzocallis* were analyzed. DNA barcoding showed 1.7% intraspecific distance between two Canadian and one American specimen of *Myzocallis* (*L.*) *bellus* (Fig. 2.32). ABGD analysis detected them as a single MOTU. However, bPTP analysis separated these Canadian and American specimens as distinct MOTUs. This situation requires further morphological and molecular analysis.

IV.2. *Therioaphis* (*Pterocallidium*) *trifolii*. A total of 57 specimens belonging to 3 species of *Therioaphis* were analyzed in this study. As shown in Fig. 2.24, 43 specimens of *Therioaphis* (*Pterocallidium*) *trifolii* were subdivided into two subgroups with intergroup barcode divergence of 1.9% (Fig. 2.33). Group 1 comprised of American, Canadian, and Korean specimens while group 2 only contained Canadian specimens. However, both groups formed a single MOTU according to both ABGD and bPTP analyses. There are four subspecies, *T.* (*P.*) *trifolii albae*, *T.* (*P.*) *trifolii maculata*, *T.* (*P.*) *trifolii trifolii*, and *T.* (*P.*) *trifolii ventromaculata* in of *T.* (*P.*) *trifolii* (Blackman & Eastop, 2017; Favret, 2017). Detailed molecular studies have not been conducted on this group of taxa. Thus, comparing worldwide samples of *T.* (*P.*) *trifolii* spp. is needed in future studies.

IV.3. *Tuberculatus* (*Arakawana*) *stigmatus*. Within *Tuberculatus* (*Arakawana*) *stigmatus*, two distinct subgroups were detected based on NJ tree and bPTP analyses with genetic divergence of 1.5% to 1.9% (Figs 2.3 and 2.34). Individuals in group 1 and group 2 showed distinct morphological features (Fig. 2.35). Group 2 has shorter siphunculi and small abdominal marginal tubercles without marginal tubercle on the 5th abdominal segment (Fig. 2.35). Based on their morphological differences, group 1 and group 2 might be distinct species despite the relatively low divergence level between these two subgroups.

IV.4. *Tuberculatus* (*Nippocallis*) *kuricola*. Among 38 individuals of *Tuberculatus* (*Nippocallis*) *kuricola*, two subgroups (group 1 and group 2) were detected based on NJ tree and bPTP analysis (Fig. 2.3). Genetic divergence between the two groups was 1.9% (Fig. 2.36). Morphologically, the two groups are superficially similar. However, group 2 can be recognized by having 3–4 setae on each dorsal abdominal tubercle (rather than 2 in group 1) with a shorter ultimate rostral segment (Fig. 2.37). Takahashi (1936) has described subspecies *T.* (*N.*) *kuricola cantoensis*. However, it is currently unclear whether *T.* (*N.*) *kuricola cantoensis* and *T.* (*N.*) *kuricola kuricola* correspond to these two genetically divided subgroups.

2.4. Discussion

This study demonstrates that DNA barcoding can be used to reliably identify aphid species in the subfamily Calaphidinae. DNA barcoding of 115 morphospecies (899 sequences) revealed 25 discordances between DNA barcoding results and morphology results. These conflicts involved 18 cases of exceptionally high intraspecific distances, three morphologically distinct species pairs with low genetic distances and four cases of ambiguous intraspecific distances. Except for four undeterminable cases, a total of 15 cryptic species were identified from 12 morphospecies. Among these cases, slight morphological differences were detected in seven species complexes. In the most cases, morphological differences were due to different lengths of various body parts rather than a different shapes or numerical characters. Slight length differences are easy to be overlooked. They can be obscured by intraspecific variations. From these results, I can infer the presence of cryptic diversity in Calaphidinae.

In this study, distinct host plant associations were revealed in three species complexes: *Mesocallis corylicola*, *Tinocallis* (*Tinocallis*) *zelkowae* and *Tuberculatus* (*Acanthocallis*) *quercicola*. Differences in host plant associations are often critical for aphid species identification. Host plant shifts and subsequent genetic differentiation can lead to speciation (ecological species concept) (Via, 2000; Drès & Mallet, 2002; Peccoud et al., 2009; Schluter et al., 2009). These ecological differences between cryptic species emphasize the necessity to reexamine different host plant associated populations in a single species.

I also confirmed that species with a wide distribution could have more possibilities to include cryptic species. Some species assessed in this study demonstrated this assumption. For example, *Calaphis flava*, which has been known as invasive species with cosmopolitan distribution, included subgroups with each restricted collection area. However, most previous DNA barcoding studies in aphids targeted samples only collected within restricted area (Lee, 2011; Chen et al., 2012; Rohitha, 1982). My results suggest that multiregional sampling would be very important to recognize cryptic diversity.

However, I also found deep intraspecific divergence within species complexes without obvious host plant and geographic difference. In fact, groups within *Takecallis arundicolens* and *Tuberculatus* (*Nippocallis*) *kuricola* were found together within the same individual colony, respectively. In particular, viviparous females of *T. arundicolens* (group 1 and group 3) were not distinguishable by morphology. Considering that both bamboo and chestnut trees are urban landscape plants, the phenomenon (genetically distinct groups occur in the same colony) might indicate that human mediated transportation might have played a role in subsequent colony merging.

I found three morphologically distinct species pairs with relatively low genetic distances: *Pterocallis alnijaponicae* and *P. nigrostriata*, *Tiliaphis pseudoshinae* and *T. shinae* and *Tuberculatus* (*Orientuberculoides*) *capitatus* and *T.* (*O.*) *fangi*. This could be due to many reasons such as rapid radiation, balanced polymorphism and introgressive hybridization (Sturmbauer & Meyer, 1992). In the three DNA barcode sharing species pairs, it was common that each pair of species was collected together on the same host plants and geographical regions. Considering that, there can be opportunities of hybridization between species pair during sexual reproduction on the same host plant. Such phenomenon has been frequently reported in several taxa of aphids (Guldemond et al., 1994; Thieme & Dixon, 1996; Delmotte et al., 2003). However, conducting additional ecological and molecular research is needed to verify whether barcode sharing is due to hybridization.

In insects, species delimitation threshold value from 2 to 5% of divergence, depending on the group, is generally accepted as a means to estimate species boundaries. For example, 2% intraspecific divergence may indicate the existence of hidden species in Lepidoptera (Hajibabaei et al., 2006; Zahiri et al., 2014). However, within Diptera, this level of divergence only represents an intraspecific difference (Meier et al., 2006; Renaud et al., 2012; Nzelu, 2015). In the suborder Heteroptera, threshold value of 2.2% has been applied for DNA barcode based species delimitation (Park et al., 2011). In this study, about 2.5% of species delimitation value could be applied for most of species. However, there is clear limits applying certain species delimitation threshold value in every case. In this study, highly varied interspecific genetic variation for *COI*, from 0.5% to 20.1% were found between congeneric species of Calaphidinae. These results suggested that applying a single threshold value might not work for all members in this group. To get more accurate species delimitation results, combination of additional information such as different genetic markers, morphological characters, and ecological differences is required. For example, in the present study, morphological re-examination of two species, *Tuberculatus* (*Arakawana*) *stigmatus* and *Tuberculatus* (*Nippocallis*) *kuricola*, with intraspecific divergence of 1.9% resulted in the detection of morphological differences, suggesting that additional species are present.

Some aphid species are important pest of various crop and ornamental plants. They play a critical role in ecosystems. Although DNA barcoding has been carried out several times for aphids before, most studies have been mainly focused on the largest subfamily Aphidinae with less emphasis on other subfamilies (Lee et al., 2011; Foottit et al., 2008; Foottit et al., 2009; Coeur d'Acier et al., 2014). DNA barcodes produced in this study are of value in aiding in the identification of species of Calaphidinae. Further, remarkable cryptic diversity and suspicious cases such as barcode sharing species pairs are detected in this study. My findings suggest that many more cryptic diversity are not yet been uncovered in aphids. For more accurate and higher resolution of possibly overlooked species diversity investigation, future studies should focus on well-designed sampling plan to reflect morphological, ecological and distributional diversities within species.

Table 2.1. Genetic divergences in different taxonomic level within Calaphdinae

Comparison within	Mean (%)	Minimum (%)	Maximum (%)
Species	0.7	0	16.6
Genus	21.1	0	9.5
Subtribe	13.4	3.4	22.8
Tribe	13.8	3.4	23.1

Table 2.2. Nineteen cases of having high intraspecific distances

Subtribe	Species	No. of subgroups	Max. Intraspecific distance
Calaphidina	*Calaphis flava*	3	6.1 %
Monaphidina	*Monaphis antennata*	2	2.9 %
Myzocallidina	*Myzocallis boerneri*	2	8.2 %
	Myzocallis coryli	2	3.4 %
	Tuberculatus annulatus	2	5.5 %
	Tuberculatus higuchii	4	4.1 %
	Tuberculatus indicus	2	2.9 %
	Tuberculatus kashiwae	2	5.5 %
	Tuberculatus punctata	2	6.6 %
	Tuberculatus querceus	2	8.2 %
	Tuberculatus quercicola	2	6.0 %
	Tuberculatus yokoyamai	2	4.1 %
Panaphidina	*Eucallipterus tiliae*	2	2.9 %
	Mesocallis corylicola	2	7.1 %
	Shivaphis celti	2	16.6 %
	Takecallis arundicolens	3	10.4 %
	Therioaphis trifolli	2	1.9 %
	Tiliaphis shinae	2	10.3 %
	Tinocallis zelkowae	2	6.6 %

Table 2.3. Case of sharing low genetic distances between morphologically distinct species pairs

Subtribe	**Species 1**	**Species 2**	**Genetic distance**
Myzocallidina	*Tuberculatus capitatus*	*Tuberculatus fangi*	0.5–1.3%
Panaphidina	*Pterocallis alnijaponicae*	*Pterocallis nigrostriata*	0.5%
	Tiliaphis pseudoshinae	*Tiliaphis shinae*	1.7–1.9%

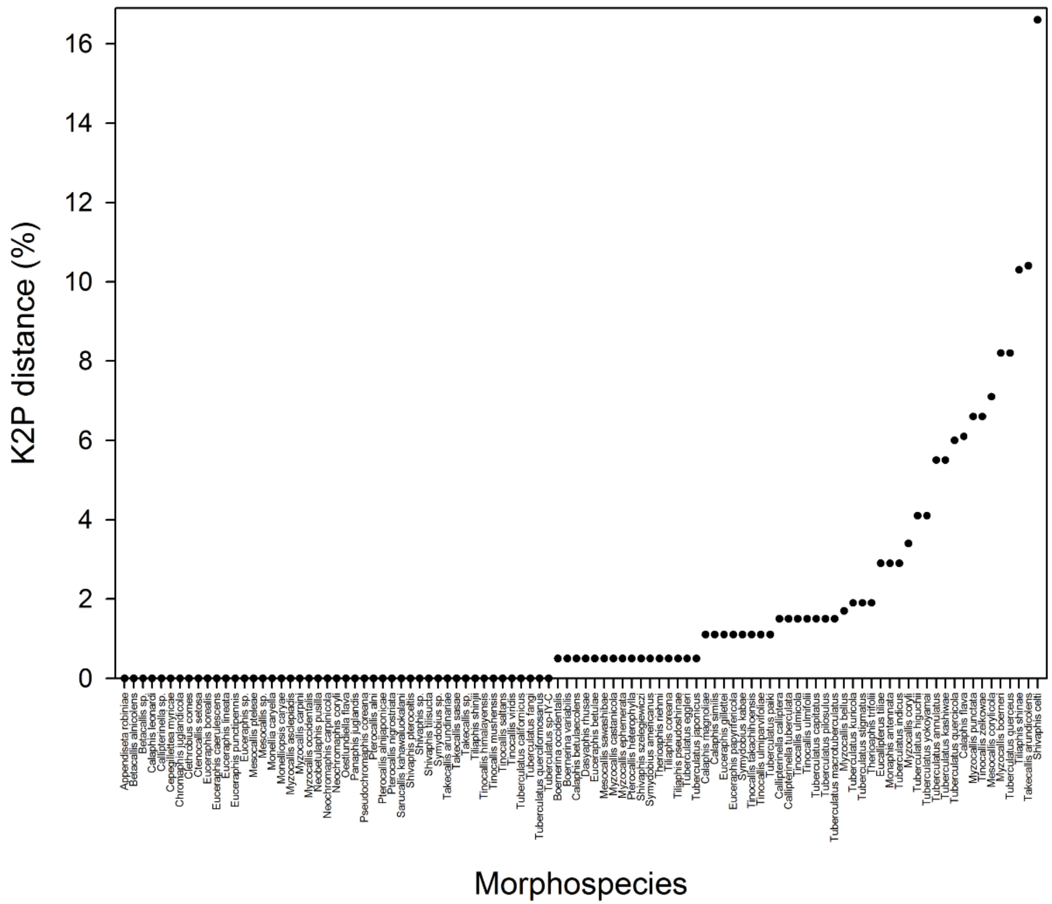

Fig. 2.1. Maximum intraspecific distances (%) based on Kimura-2-parameter (K2P) for 100 morphospecies.

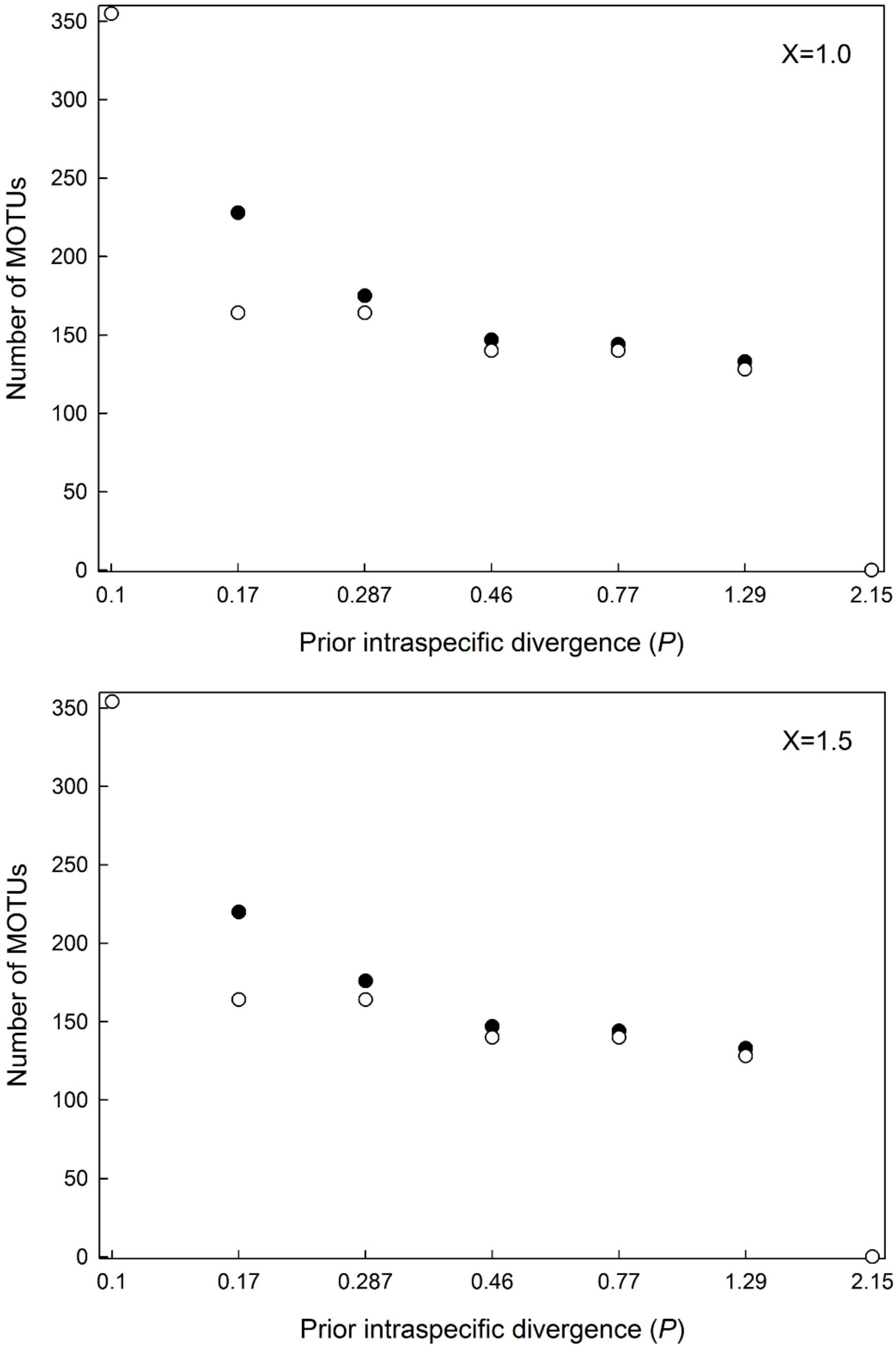

Fig. 2.2. Number of MOTUs by the prior intraspecific divergence using ABGD with two values of relative gap width. (A) X=1. (B) X=1.5.

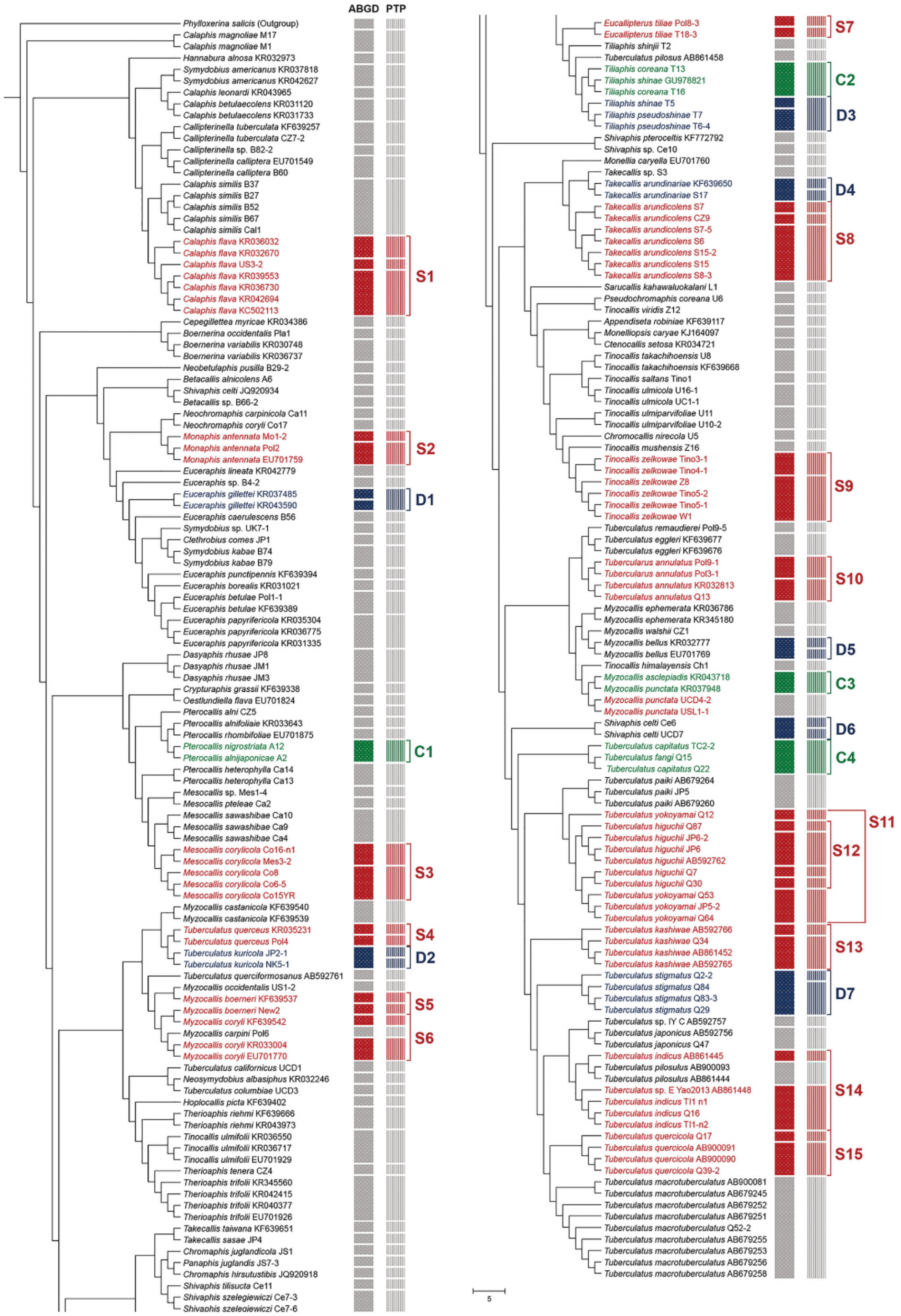

Fig. 2.3. Maximum likelihood COI gene tree with deliminated MOTUs by ABGD and PTP analyses. (Red S) Subdivided morphospecis. (Green C) combined morphologically different species. (Blue D) discordant between ABGD and PTP results.

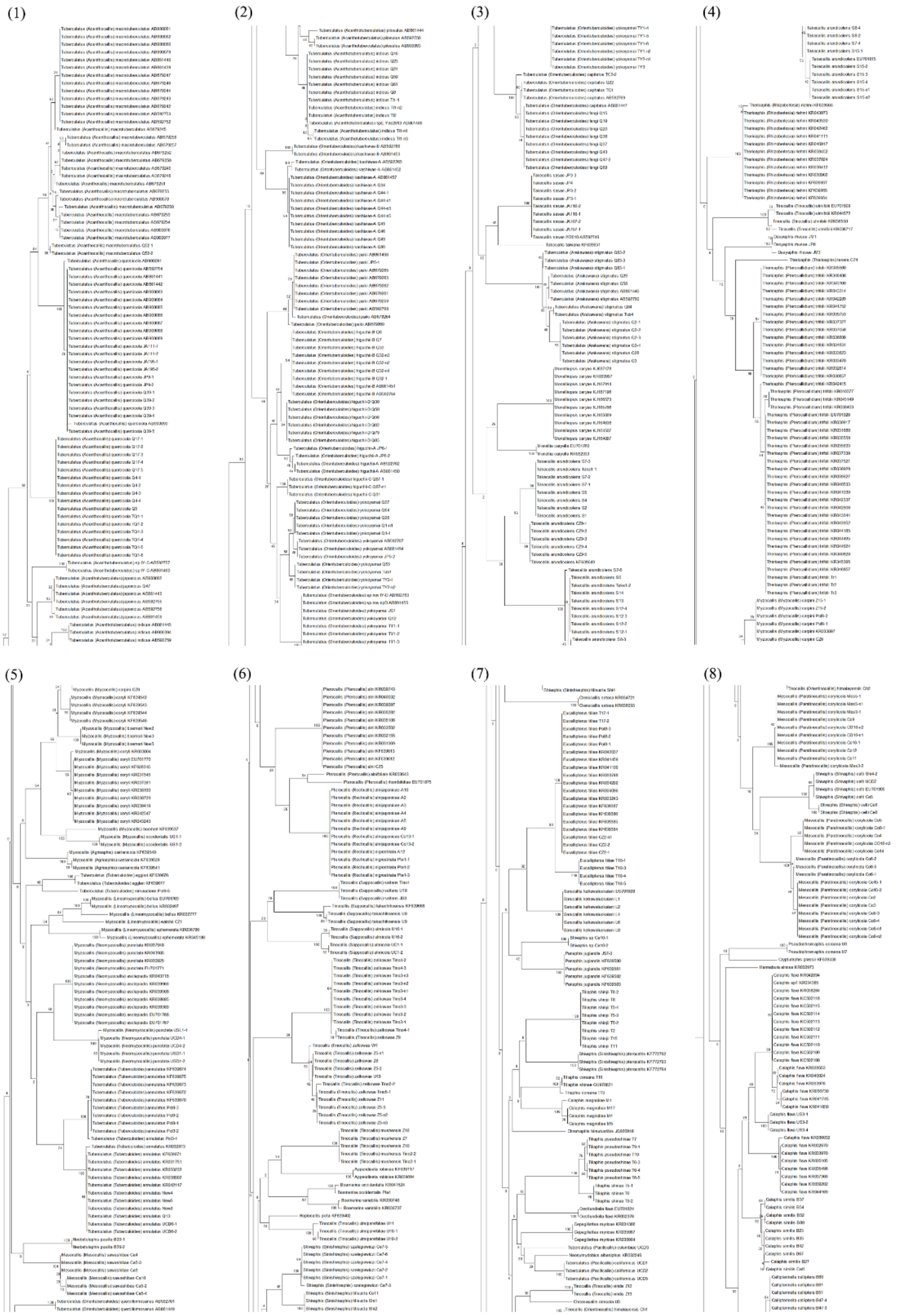

Fig. 2.4. Neighbor-joinig tree for the 899 individuals of 115 morphospecies based on COI barcoding region.

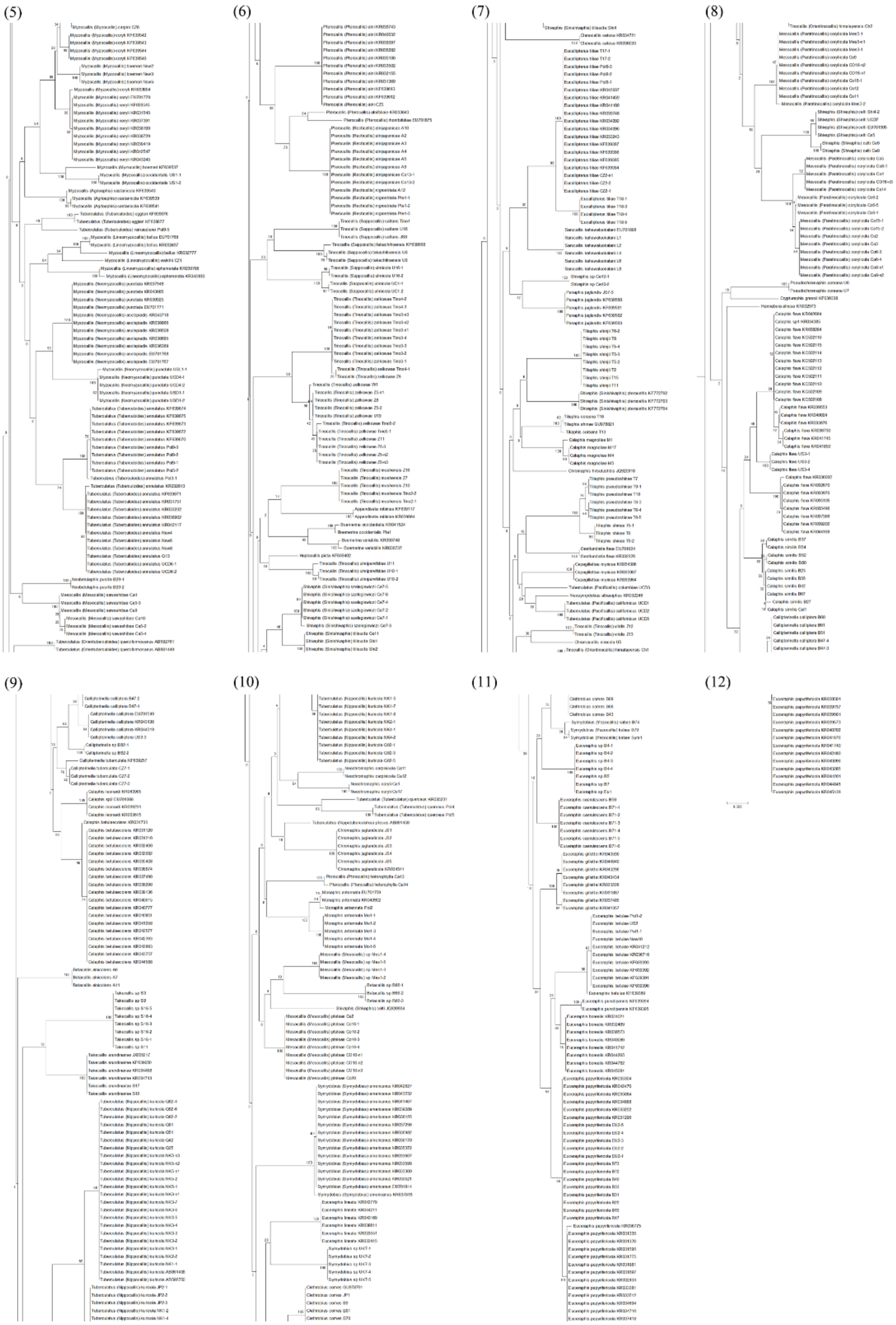

Fig. 2.4. (continued)

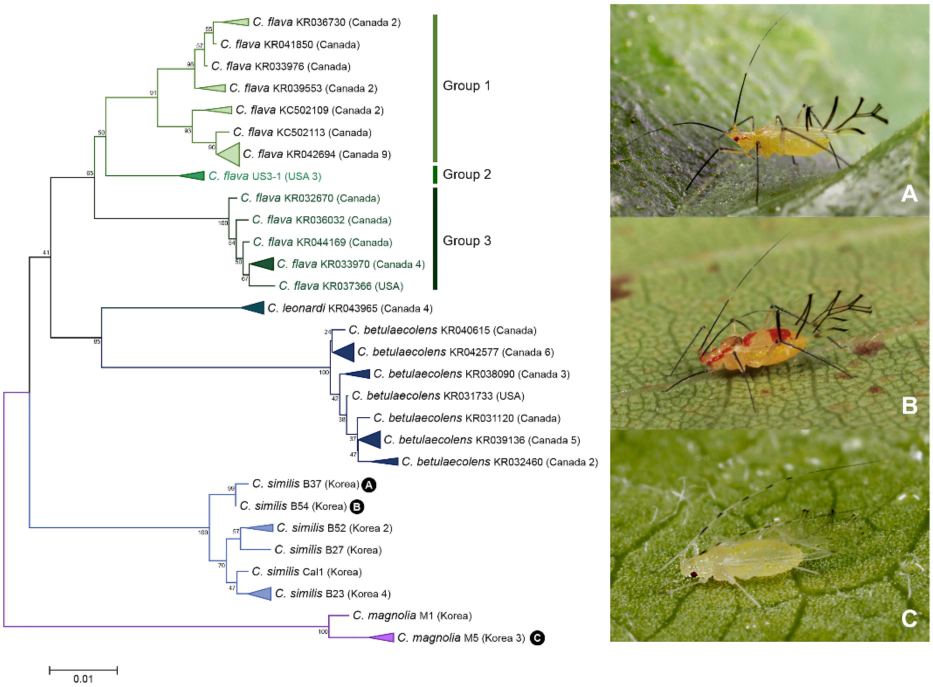

Fig. 2.5. Neighbor-joining tree of *COI* partial gene sequences of *Calaphis* spp. (66 sequences of 5 morphospecies).

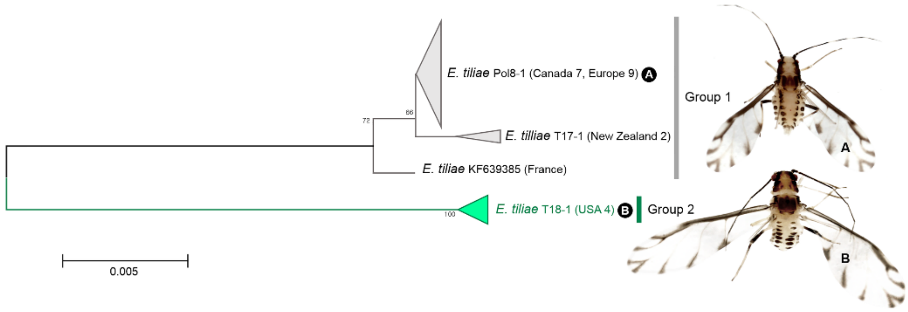

Fig. 2.6. Neighbor-joining tree of *COI* partial gene sequences of *Eucallipterus* spp. (23 sequences).

Fig. 2.7. Alate vivipara of 2 subgroups of *Eucallipterus tiliae* group 1 (A-B) and group 2 (C-D). (A, C) antenna. (B, D) 2nd segment of hind tarsi (scale bars, 0.1mm).

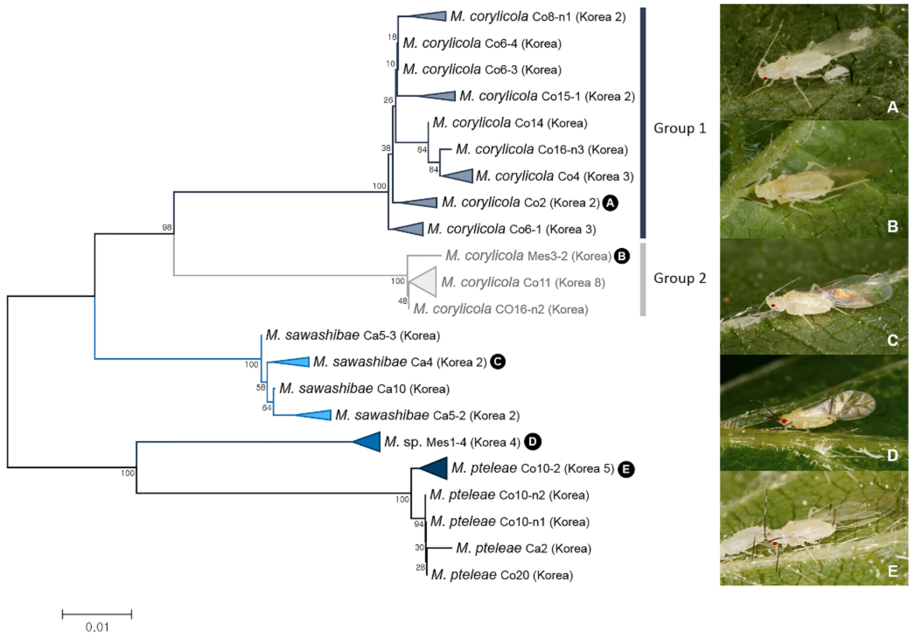

Fig. 2.8. Neighbor-joining tree of *COI* partial gene sequences of *Mesocallis* spp. (45 sequences of 4 morphospecies).

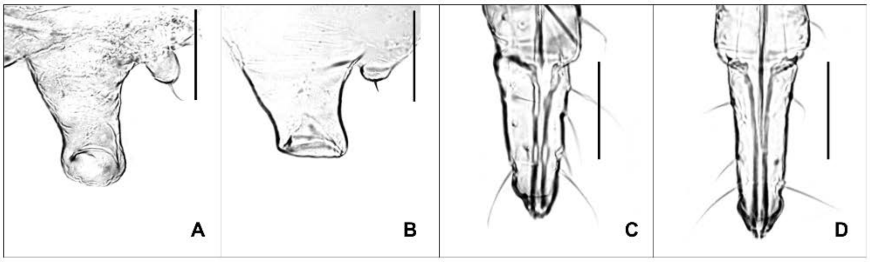

Fig. 2.9. Alate vivipara of 2 subgroups of *Mesocallis corylicola* group 1 (A, C) and group 2 (B, D). (A-B) siphunculi. (C-D) ultimate rostral segment (scale bars, 0.05mm).

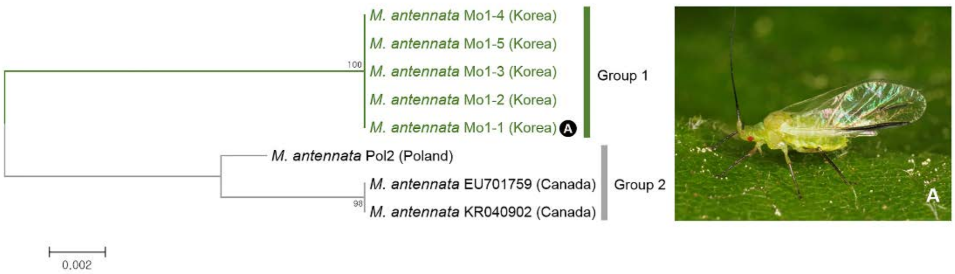

Fig. 2.10. Neighbor-joining tree of *COI* partial gene sequences of *Monaphis antennata* (8 sequences).

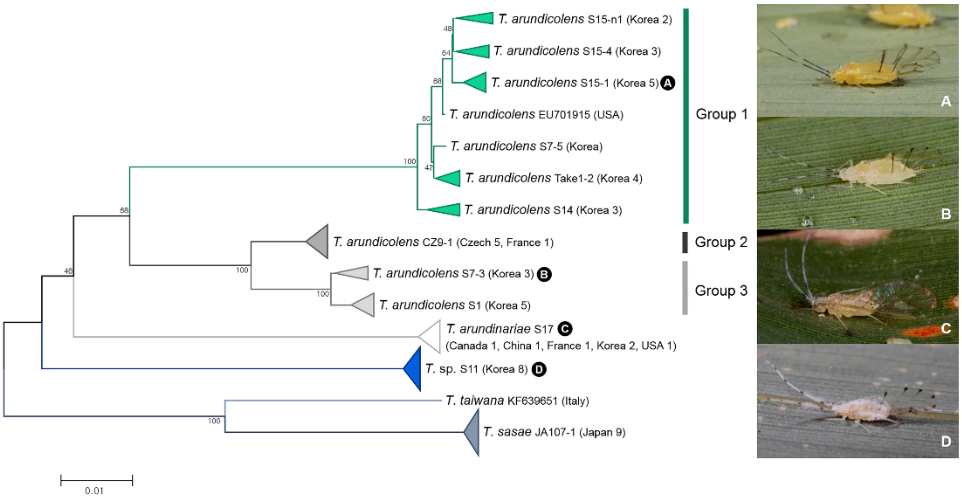

Fig. 2.11. Neighbor-joining tree of *COI* partial gene sequences of *Takecallis* spp. (58 sequences of 5 morphospecies).

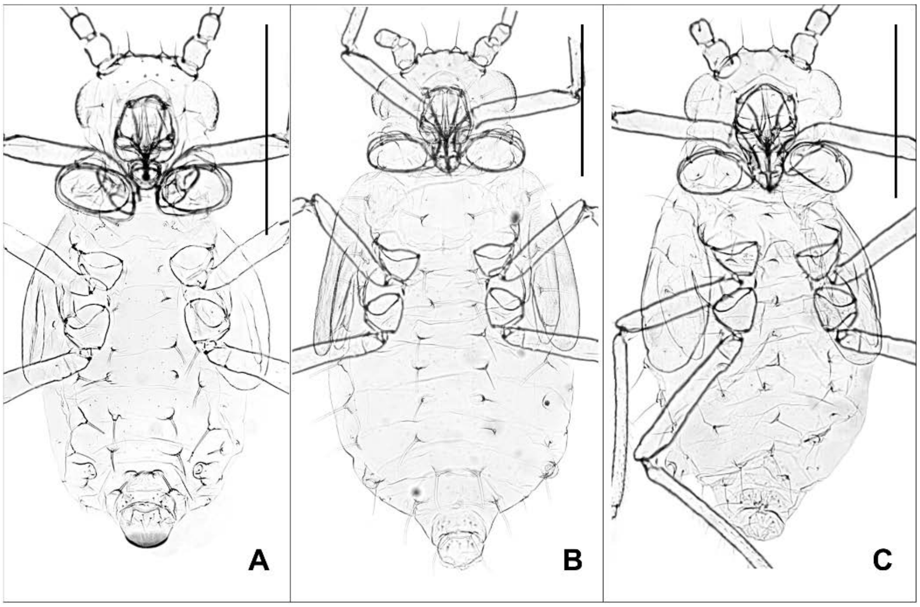

Fig. 2.12. Alatoid nymph of 3 subgroups of *Takecallis arundicolens* group 1 (A), group 2 (B) and group 3 (C). (A-C) body (scale bars, 0.5mm).

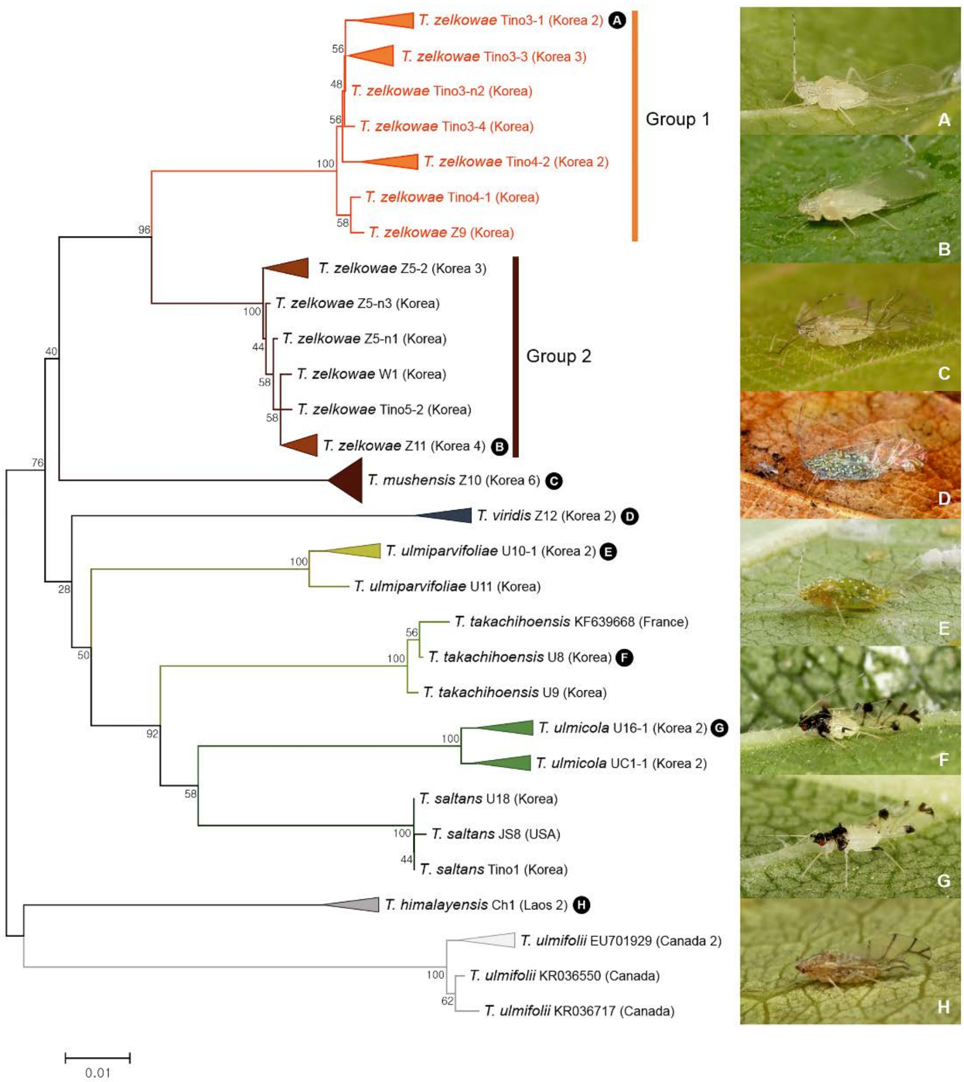

Fig. 2.13. Neighbor-joining tree of *COI* partial gene sequences of *Tinocallis* spp. (48 sequences of 9 morphospecies).

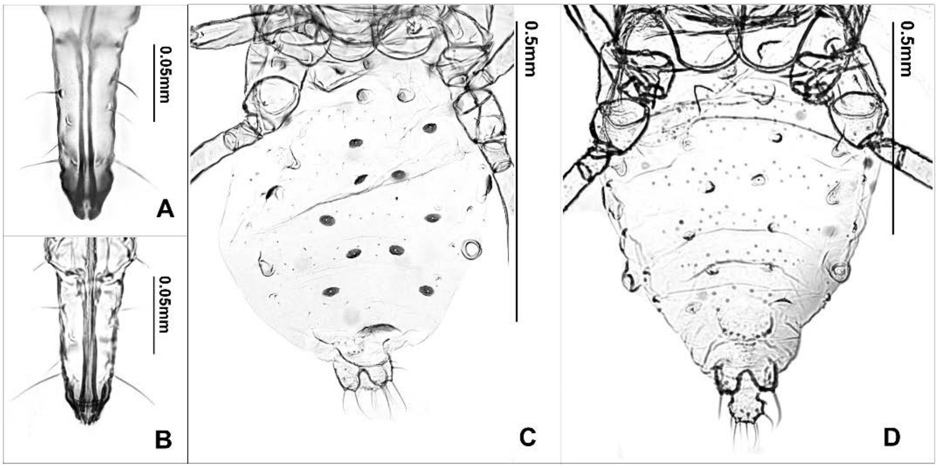

Fig. 2.14. Alate vivipara of 2 subgroups of *Tinocallis zelkowae* group 1 (A, C) and group 2 (B, D). (A-B) ultimate rostral segment. (C-D) abdomen.

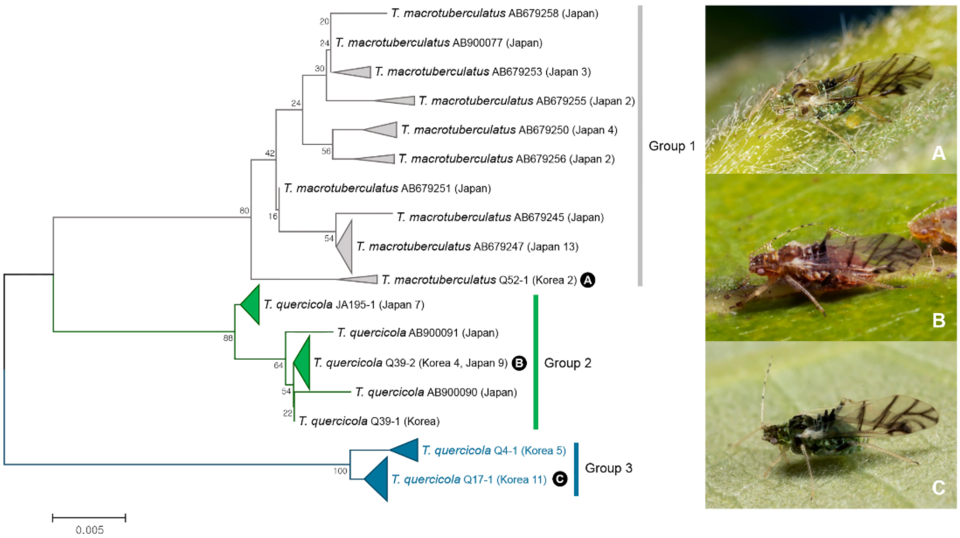

Fig. 2.15. Neighbor-joining tree of *COI* partial gene sequences of subgenus *Acanthocallis* spp. (69 sequences of 2 morphospecies).

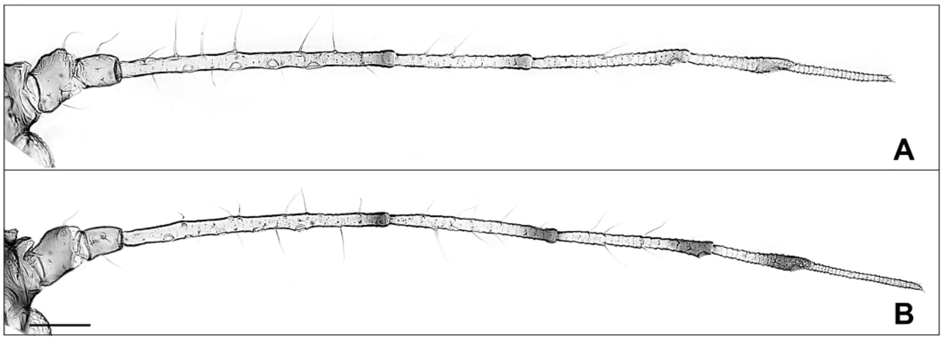

Fig. 2.16. Alate vivipara of 2 subgroups of *Tuberculatus* (*Acanthocallis*) *quercicola* group 2 (A) and group 3 (B). (A-B) antenna (scale bars 0.1mm).

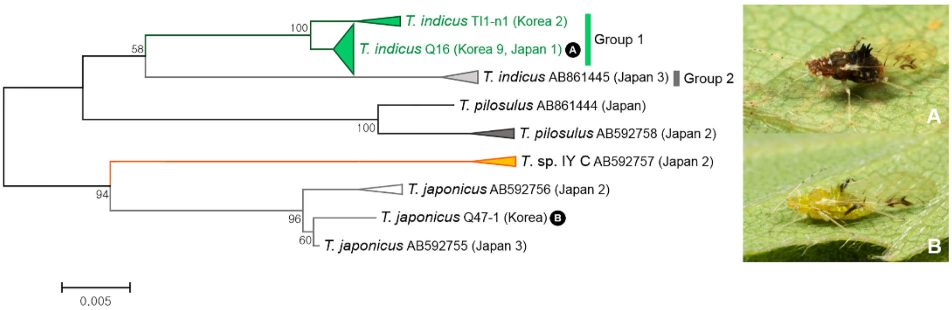

Fig. 2.17. Neighbor-joining tree of *COI* partial gene sequences of subgenus *Acanthotuberculatus* spp. (26 sequences of 4 morphospecies).

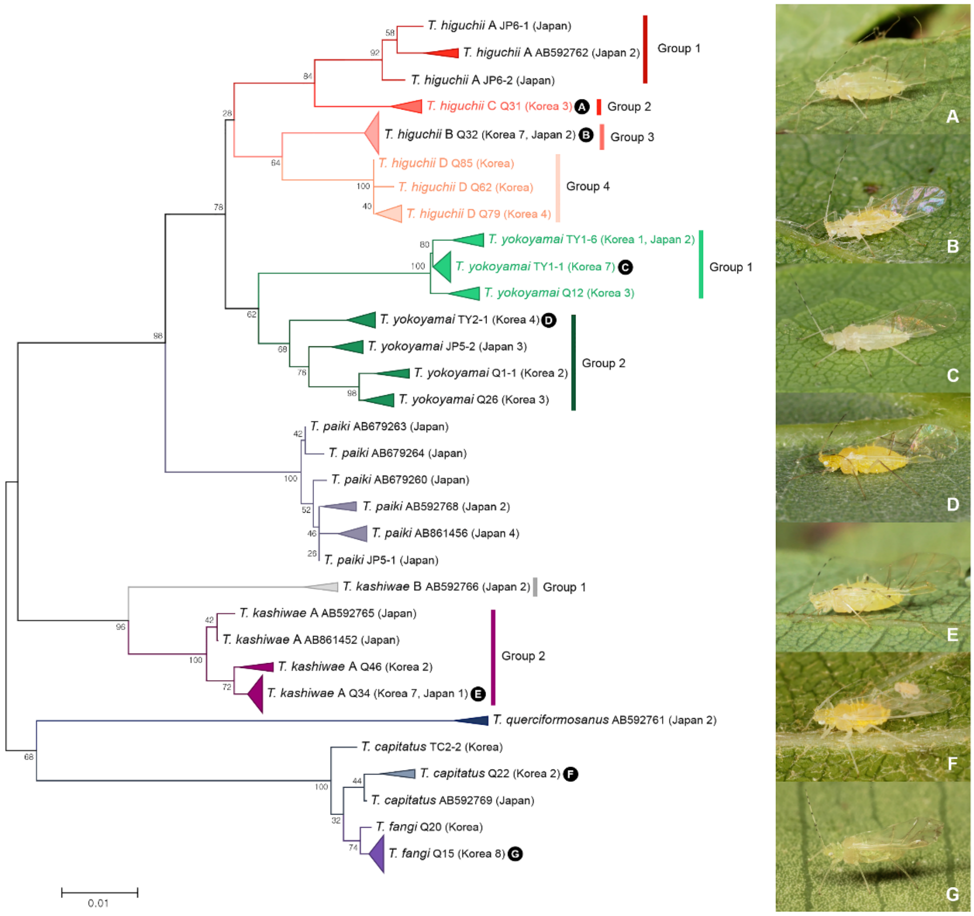

Fig. 2.18. Neighbor-joining tree of *COI* partial gene sequences of subgenus *Orientuberculoides* spp. (86 sequences of 7 morphospecies).

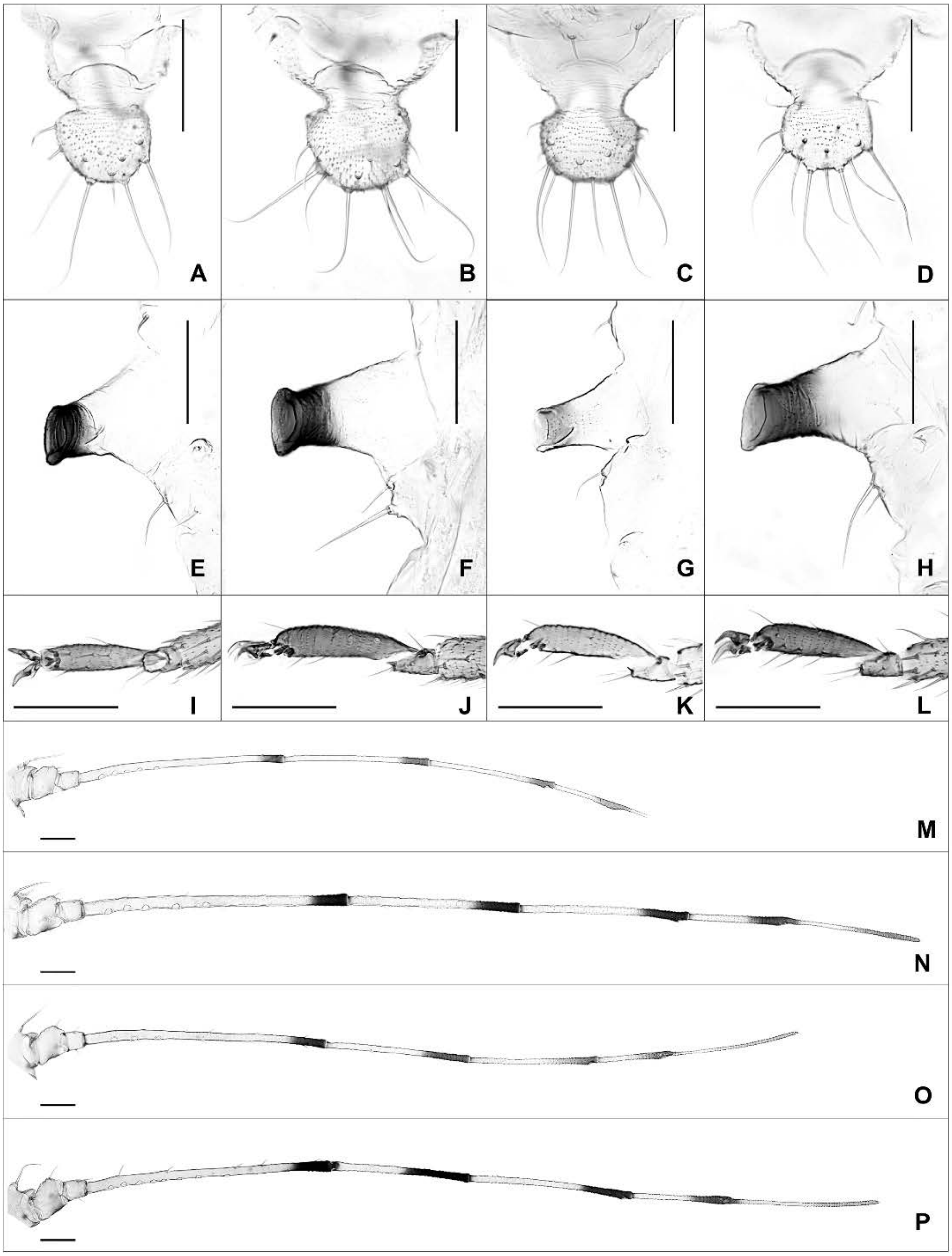

Fig. 2.19. Alate vivipara of 4 subgroups of *Tuberculatus* (*Orientuberculoides*) *higuchii* group 1 (A, E, I, M), group 2 (B, F, J, N), group 3 (C, G, K, O) and group 4 (D, H, L, P). (A-D) cauda. (E-H) siphunculi. (I-L) 2nd segment of hind tarsi. (M-P) antenna (scale bars 0.1mm).

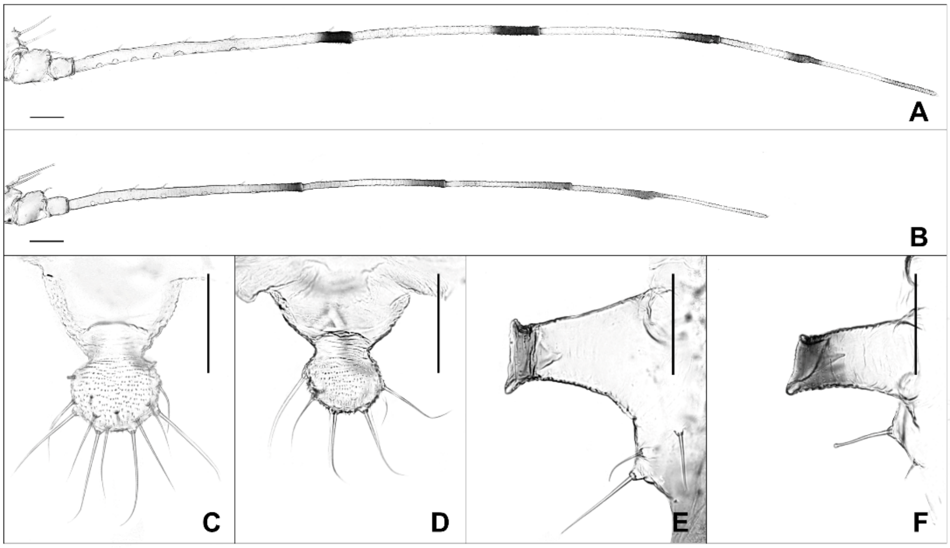

Fig. 2.20. Alate vivipara of 2 subgroups of *Tuberculatus* (*Orientuberculoides*) *yokoyamai* group 1 (A, C, E) and group 2 (B, D, F). (A-B) antenna. (C-D) cauda. (E-F) siphunculi (scale bars 0.1mm).

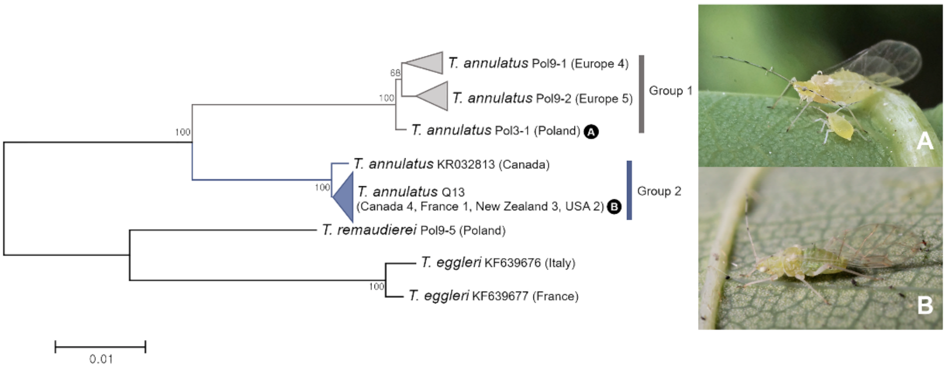

Fig. 2.21. Neighbor-joining tree of *COI* partial gene sequences of subgenus *Tuberculoides* spp. (19 sequences of 3 morphospecies).

Fig. 2.22. Alate vivipara of 2 subgroups of *Tuberculatus* (*Tuberculoides*) *annulatus* group 1 (A, C) and group 2 (B, D). (A-B) antenna. (C-D) cauda (scale bars, 0.1mm).

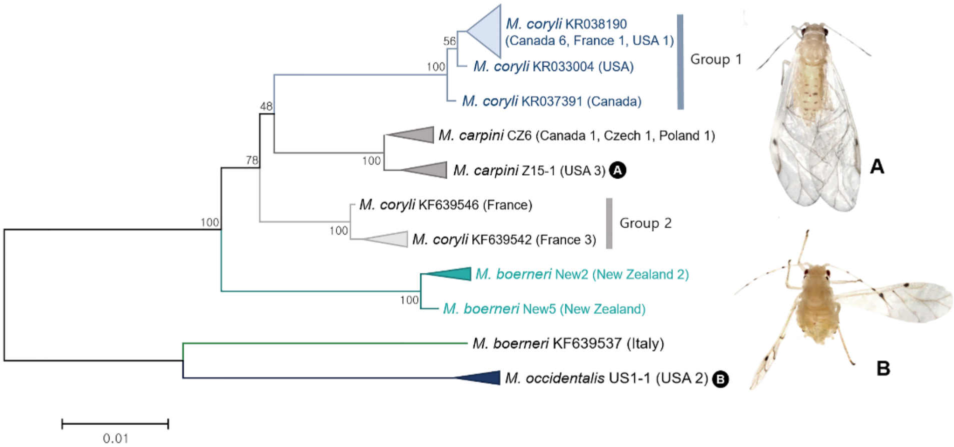

Fig. 2.23. Neighbor-joining tree of *COI* partial gene sequences of subgenus *Myzocallis* spp. (26 sequences of 4 morphospecies).

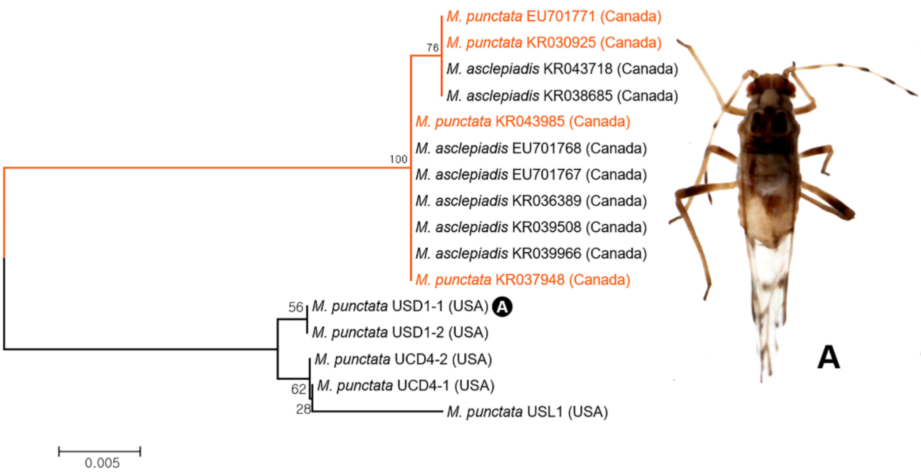

Fig. 2.24. Neighbor-joining tree of *COI* partial gene sequences of subgenus *Neomyzocallis* spp. (16 sequences of 2 morphospecies).

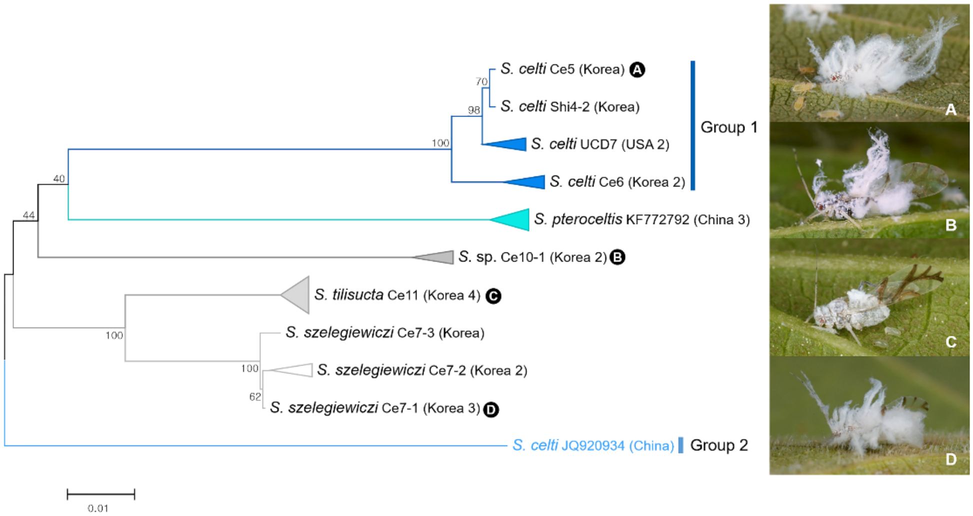

Fig. 2.25. Neighbor-joining tree of *COI* partial gene sequences of *Shivaphis* spp. (22 sequences of 5 morphospecies).

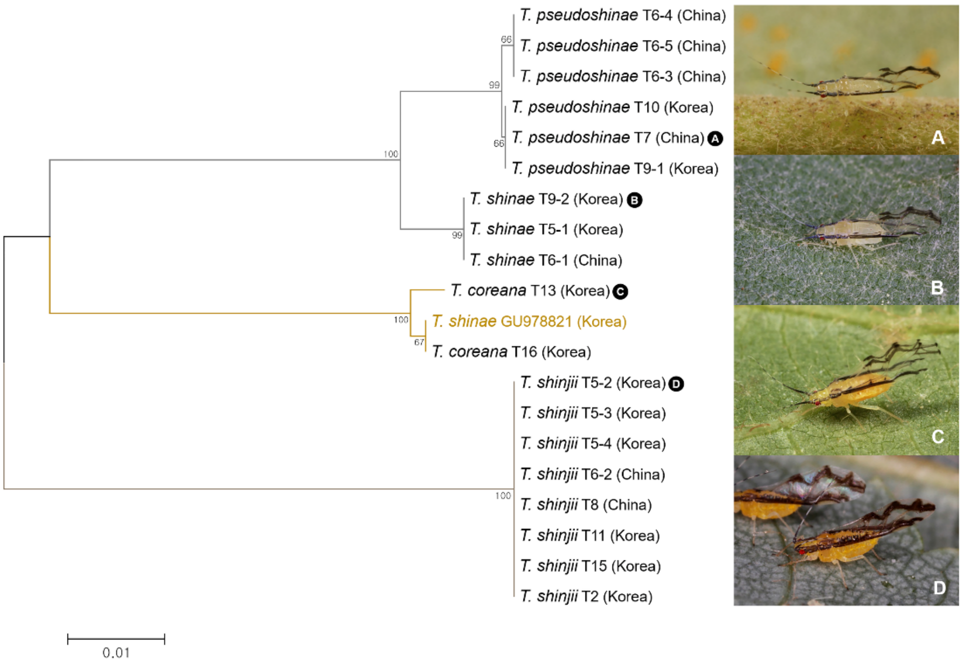

Fig. 2.26. Neighbor-joining tree of *COI* partial gene sequences of *Tiliaphis* spp. (20 sequences of 4 morphospecies).

Fig. 2.27. Neighbor-joining tree of *COI* partial gene sequences of *Tuberculatus querceus* (3 sequences).

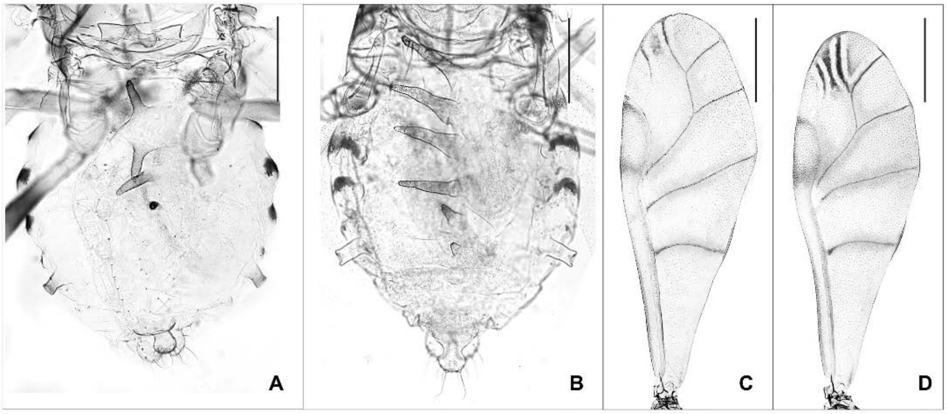

Fig. 2.28. Alate vivipara of *Pterocallis alnijapoinicae* (A, C) and *P. nigrostriata* (B, D). (A-B) abdomen. (C-D) forewing (scale bars 0.5mm).

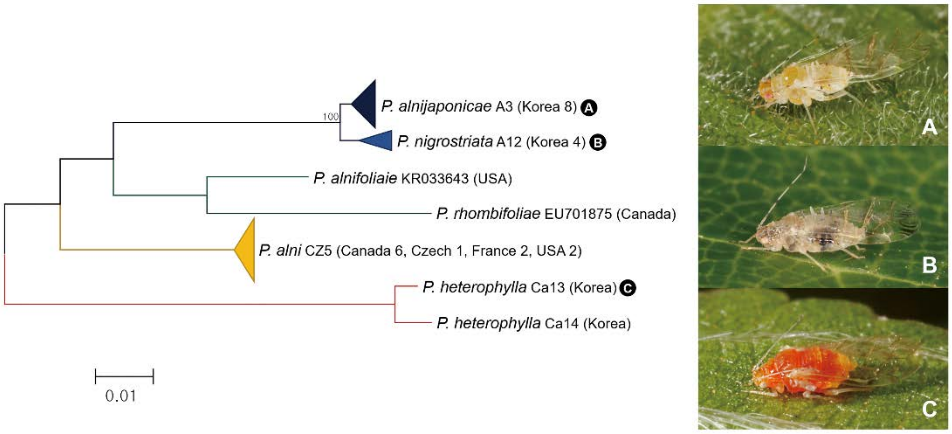

Fig. 2.29. Neighbor-joining tree of *COI* partial gene sequences of *Pterocallis* spp. (27 sequences of 6 morphospecies).

Fig. 2.30. Alate vivipara of *Tiliaphis pseudoshinae* (A, C) and *T. shinae* (B, D). (A-B) antenna. (C-D) ultimate rostral segment (scale bars 0.1mm).

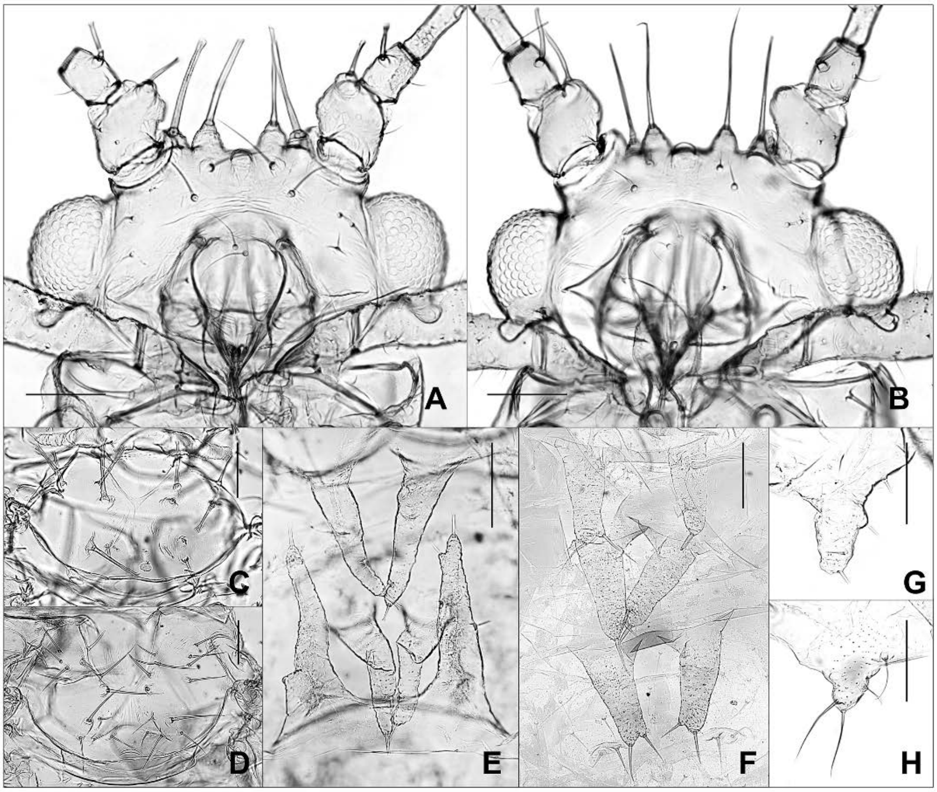

Fig. 2.31. Alate vivipara of *Tuberculaphis* (*Orientuberculoides*) *capitatus* (A, C, E, G) and *T.* (*O.*) *fangi* (B, D, F, H). (A-B) head. (C-D) setae on thorax. (E-F) abdominal dorsal tubercles. (G-H) 4th abdominal marginal tubercle (scale bars, 0.1mm).

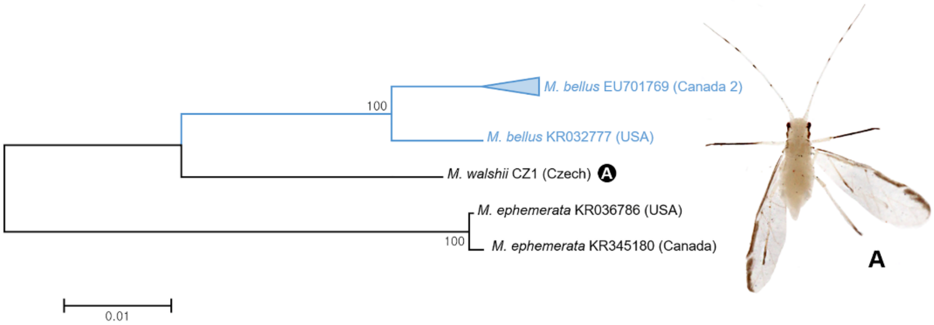

Fig. 2.32. Neighbor-joining tree of *COI* partial gene sequences of subgenus *Lineomyzocallis* spp. (6 sequences).

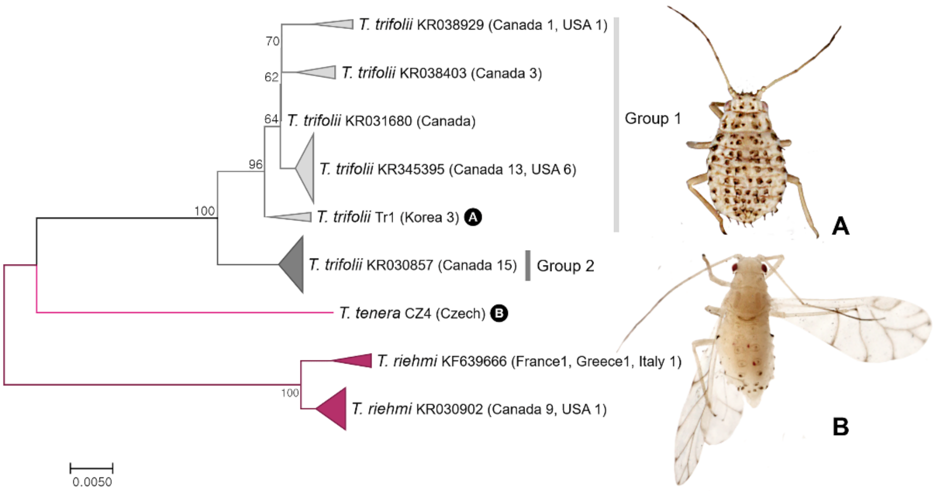

Fig. 2.33. Neighbor-joining tree of *COI* partial gene sequences of genus *Therioaphis* spp. (57 sequences of 3 morphospecies).

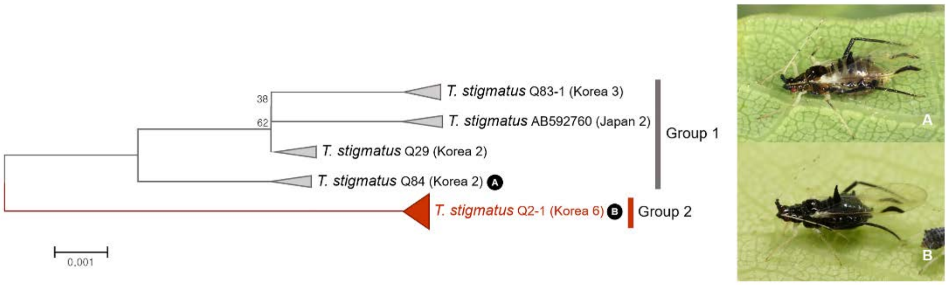

Fig. 2.34. Neighbor-joining tree of *COI* partial gene sequences of *Tuberculatus* (*Arakawana*) *stigmatus* (15 sequences).

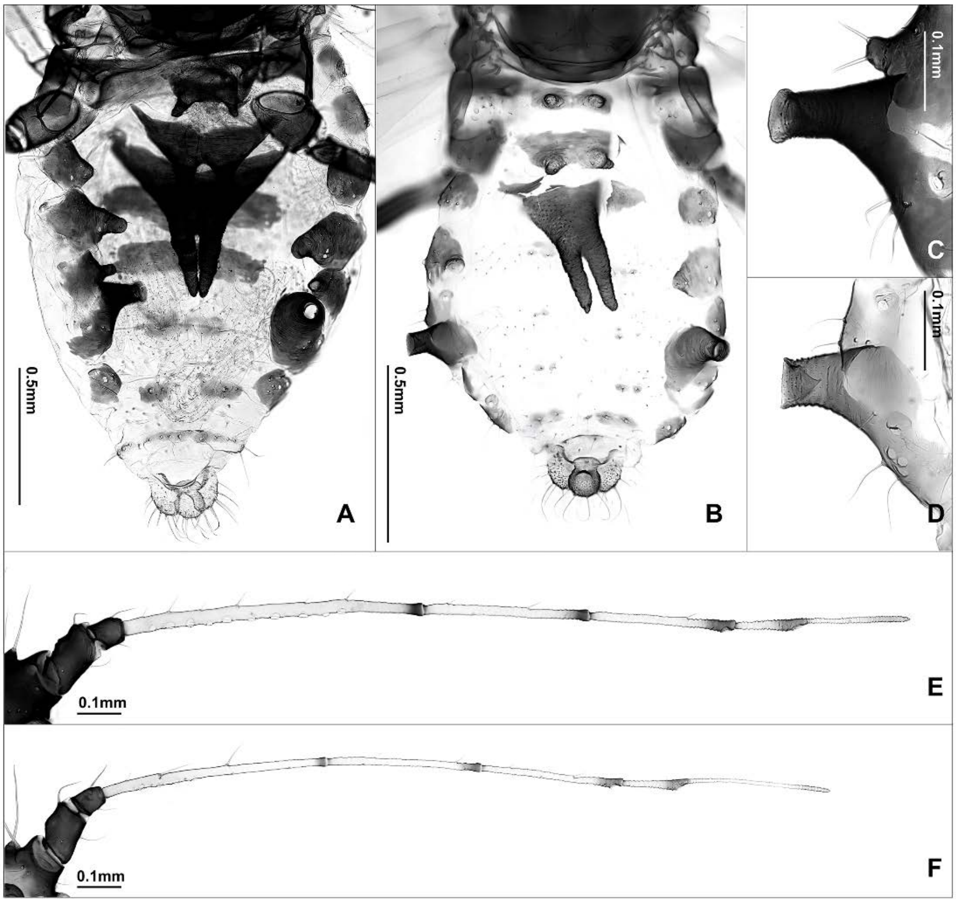

Fig. 2.35. Alate vivipara of 2 subgroups of *Tuberculatus* (*Arakawana*) *stigmatus*, group 1 (A, C, E) and group 2 (B, D, F). (A-B) abdomen. (C-D) siphunculi. (E-F) antenna.

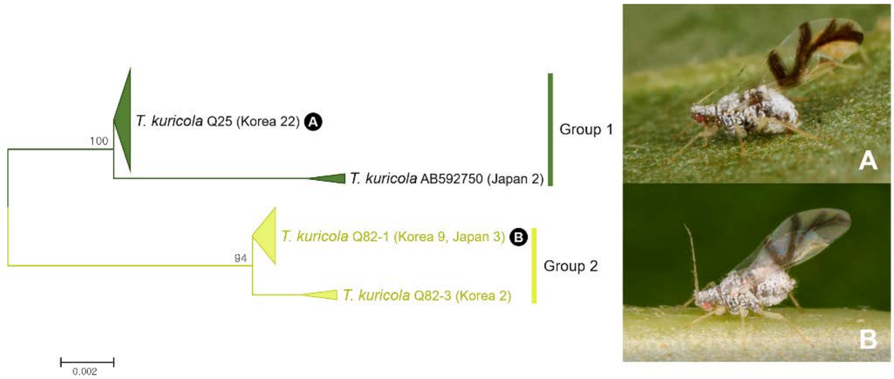

Fig. 2.36. Neighbor-joining tree of *COI* partial gene sequences of *Tuberculatus* (*Nippocallis*) *kuricola* (38 sequences).

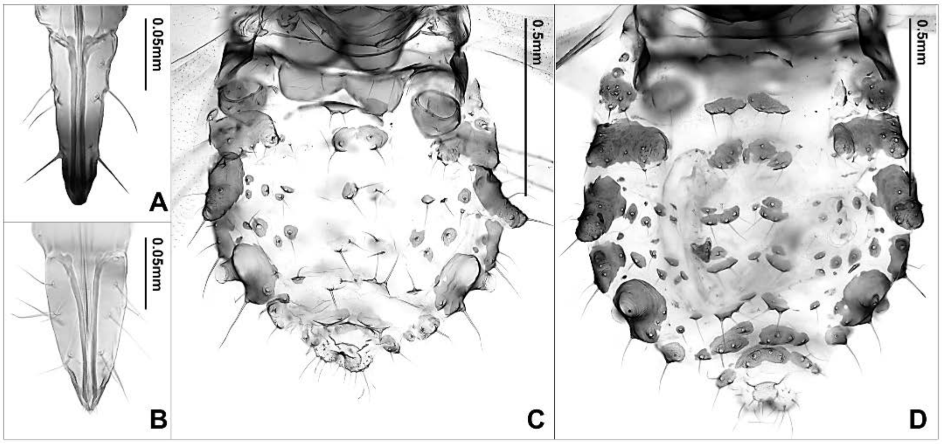

Fig. 2.37. Alate vivipara of 2 subgroups of *Tuberculatus* (*Nippocallis*) *kuricola*, group 1 (A, C) and group 2 (B, D). (A-B) ultimate rostral segment. (C-D) abdomen.

Part III. Phylogenetic reconstruction and evolutionary hypothesis of the subfamily Calaphidinae *s.l.* (Hemiptera: Aphididae)

Abstract

Phylogenetic relationship of Calaphidinae *s.l.* were studied to confirm their taxon boundary and to identify ingroup relationship. In addition, ancestral host plant reconstruction and time calibration were conducted to investigate evolutionary hypothesis of host plant association. In this study, Bayesian inference, maximum likelihood, and maximum parsimony analyses of combined 4 mitochondrial (*ATP6*, *COI*, *COII*, and *CytB*) and 1 nuclear (*EF1α*) sequences were performed. Phylogenetic results indicated that i) Calaphidinae *s.s.* is not a monophyletic, ii) Saltusaphidinae is nested within Calaphidinae *s.s.*, iii) Phyllaphidinae formed a basal node as the most primitive group of Calaphidinae *s.l.* Reconstruction of ancestral host plant of Calaphidinae *s.l.* indicated that Calaphidinae might have evolved from members of Fagales plants. Calaphidinae *s.l.* might be diverged in the late Cretaceous at about 87.3 Ma.

Keywords: ancestral host plant relationship, molecular phylogeny, Phyllaphidinae, Saltusaphidinae

3.1. Introduction

Aphid species diversification is intimately associated with their host plants, like many phytophagus insects (Tilmon et al., 2008). In general, the diversity of aphids has frequently hypothesized by their host shift and subsequent host plant range broadening rather than a cospeciation (Peccoud et al., 2010). One plausible hypotheses about aphid host shift explains that complex life cycle such as host alternation between unrelated groups of host plants (heteroecy) can mediate host plant range expension and following speciation by loss and acquisition of heteroecy (Moran, 1988; 1992). Among a total of 24 aphid subfamilies, 10% of species in the 4 subfamilies (Anoeciinae, Aphidinae, Eriosomatinae, and Hormaphidinae) take heteroecious life cycle (Peccoud et al., 2010; Blackman & Eastop, 2017). Indeed, aphid species of these 4 subfamilies represent the most various host plant relationship encompassing in aphids (Blackman & Eastop, 2017). In contrast, Calaphidinae is unusual because it is the only group comprising both woody and herbal angiosperm feeders among the rest of 20 subfamilies that only includes monoecious species (Blackman & Eastop, 2017; Favret, 2017). Therefore, studying host plant associated evolution of Calaphidinae is important to understand alternative hypothesis of heteroecy mediated host plant range broadening in aphids.

Calaphidinae (Hemiptera: Aphididae) is one of the most species rich groups of aphids including more than 370 species belonging to 59 genera in the world (Blackman & Eastop, 2017; Favret, 2017). Historically, classification of

Calaphidinae has been controversial. According to the most recent classification, this group is divided into two tribes (Calaphidini and Panaphidini) (Nieto Nafria et al., 1997; Quednau, 1999; Favret, 2017). Tribe Calaphidini has been regarded as more primitive group and comprises two subtribes (Monaphidina and Calaphidina) with about 80 describes species (Quednau, 1999; Favret, 2017). Only four described species of Monaphidina are distributed solely in the temperate region and have monoecious holocyclic lifecycles on Betulaceae and Fagaceae (Blackman & Eastop, 2017). Calaphidina contains about 73 species with a simple lifecycle. Calaphidina species only occur on woody plants belonging to less than 6 angiosperm families (Blackman & Eastop, 2017; Favret, 2017). Similar to Monaphidina, most species of Calaphidina are distributed in the temperate region except for some genera: *Betacallis*, *Betulaphis*, *Clethrobius*, and *Latgerina* (Gosh & Quednau, 1990; Blackman & Eastop, 2017). Compared to Calaphidini, Panaphidini have higher species diversity with wider host plant relationship and regional distribution. Panaphidini is divided into two subtribes, Myzocallidina and Panaphidina (Quednau, 1999; Quednau, 2003; Favret, 2017). Myzocallidina encompasses about 145 species, with a simple life cycle on woody and herbaceous plants (Quednau, 1999). Host plant diversity of Myzocallidina is much narrower than those of Panaphidina (Quednau, 1999). Of all subtribes, host plant range of Panaphidina is most diverse (Quednau, 2003). The approximately 144 species of Panaphidina have been recorded in the temperate and subtropical regions and follow simple life cycles on 17 plant families including various woody and herbaceous plants (Gosh & Quednau, 1990; Quednau, 2003; Favret, 2017).

In aphids, first attempt of molecular phylogeny had performed by Dohlen & Moran (2000) for 38 species of 12 subfamilies based on two partial ribosomal RNA genes. In this study, four species of Calaphidinae and one species of Saltusaphidinae formed a monophyletic clade and Tamalinae formed a sister clade (Fig. 3.1A). However, as authors said, phylogenetic resolution was too low to determine relationships between groups (von Dohlen & Moran, 2000). In 2001, Martinez-Torres et al. constructed molecular phylogenetic tree for 33 species of 5 subfamilies based on partial genes of aphids and *Buchnera aphidicola*. Calaphidinae (2 species of Panaphidihi) formed monophyletic clade although higher phylogenetic relationship of Calaphidinae was inconsistent between aphid and *Buchnera* trees (Fig. 3.1B). In the phylogenetic tree of *Buchnera* sequence, Chaitophorinae formed sister clade of Calaphidinae (Fig. 3.1B). However, in the aphid sequence based tree, Calaphidinae is in between Thelaxinae and Drapanosiphinae+Chaitophorinae clade (Fig. 3.1A). This system was revised later by Ortiz-Rivas et al. (2004; 2010) in the molecular phylogenetic studies on Aphididae of 62 species of 10 subfamilies. In this important system, authors suggested three main lineages named L lineage: the most primitive lineage Lachninae, E+T lineage (Anoeciinae, Eriosomatinae, Hormaphidinae, Mindarinae, and Thelaxinae), and A+D lineage (Aphidinae, Calaphidinae, Chaitophorinae, and Drepnosiphinae) (Figs 3.1C and 3.1D). According to these studies, Chaitophorinae+Drepanosiphinae formed a sister clade of Calaphidinae and Aphidinae formed their basal lineage (Figs 3.1C and 3.1D). Most recently, phylogenetic study of Aphididae was performed by Novakova et al. (2013) for 70 species of 15 subfamilies based on 5 *Buchnera* genes. In this study, subfamily

Saltusaphidinae was included in the Calaphidinae (Fig. 3.1E). Unlike Ortiz-Rivas et al. (2004; 2010), a close relationship between Aphidinae and Calaphidinae was highly supported rather than Chaitophorinae and Drepanosiphinae.

In this study, I focused on the phylogenetic reconstruction of subfamily Calaphidinae *s.l.* Until now, phylogenetic relationship within this group is not yet been identified and drow a clear picture is challenging as ever. Additionally, it is necessary to clarify the correct taxon boundaries of true Calaphidinae. Another objective of this study is investigate ancestral host plant relationship and timing of rapid radiation.

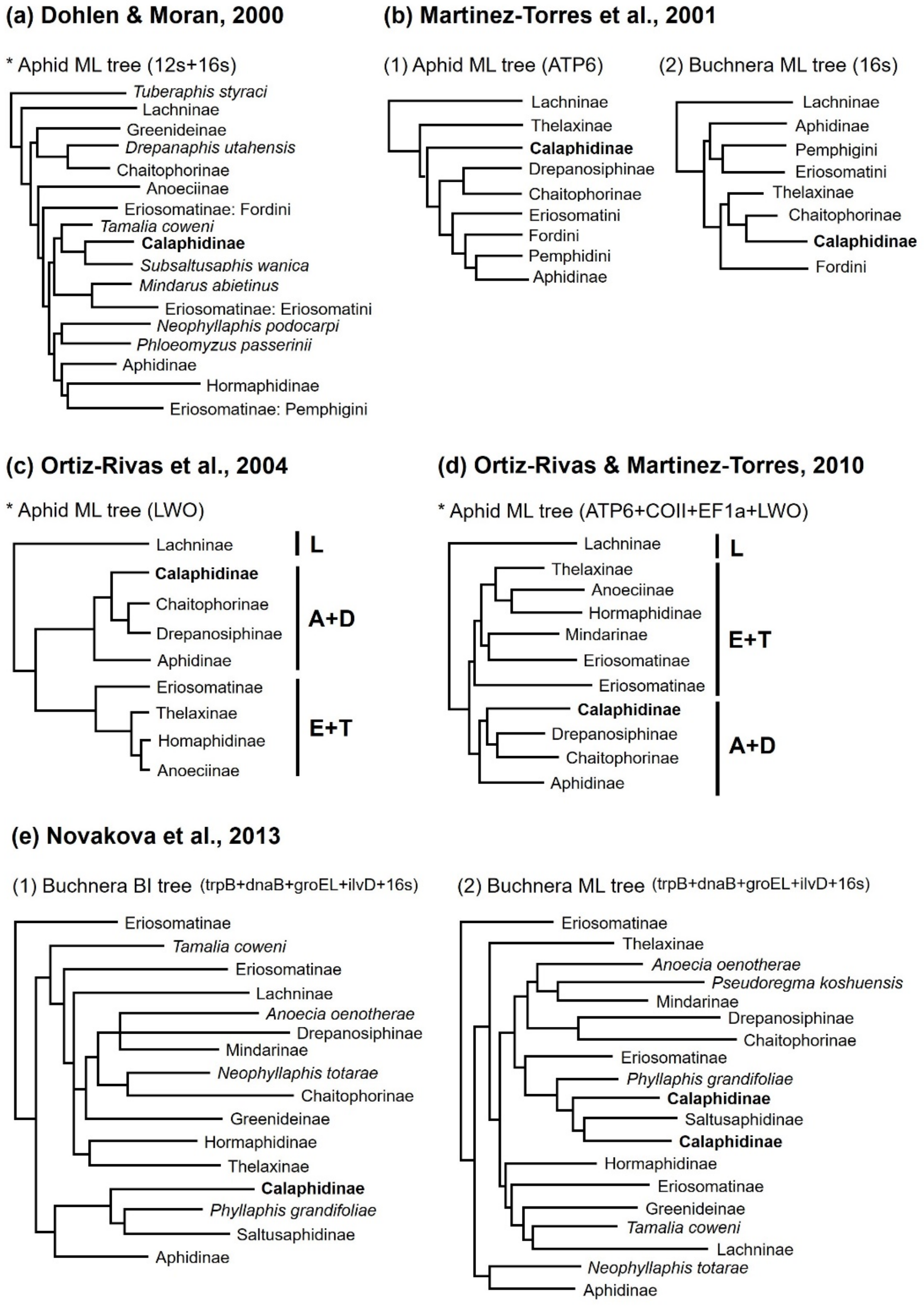

Fig. 3.1. Molecular phylogenetic studies on the family Aphididae

3.2. Materials and Methods

3.2.1. Taxon sampling

A total of 101 calaphidine species of 29 genera were collected from Asia: China, Iran, Japan, Korea, Laos, and Myanmar; Europe: Czech republic, Italy, Poland, and UK; North America: USA; and Oceania: New Zealand. Detailed collection informations of each species are listed in the table 3.1. This dataset encompasses all known subtribes of Calaphidinae and comprises about 49.2% of the whole known genera. In addition, one species was downloaded from Genbank. On the basis of current phylogenetic hypothesis of Aphididae (von Dohlen & Moran, 2000; Martínez-Torres, 2001; Ortiz-Rivas et al., 2004; Ortiz-Rivas & Martínez-Torres, 2010; Novakova et al., 2013), a total of 14 possible congruent species (6 species of Phyllaphidinae and 8 species of Saltusaphidinae), 17 sister group species (9 species of Aphidinae, 4 species of Chaitophorinae, 3 species of Drepanosiphinae, and 2 species of Eriosomatinae), and 11 outgroup species (1 species of Adelgidae, 9 species of Lachninae, 1 species of Phylloxeridae) from Aphidomorpha were included in the dataset. As a result, the final dataset consisted of 145 species (Tables 3.1 and 3.2). All samples were collected directly into 70-95% ethanol and stored at -20°C for generic DNA extraction. In this study, all taxon names follow Nieto Nafria et al., 2011.

3.2.2. Specimen vouchering, DNA extraction, PCR amplification and sequencing

To examine morphological identification and perform DNA extraction at a same time, nondestructive DNA extraction method was used: each whole-bodied specimen was put into a mixture of 90μl of ATL buffer and 10 μl of proteinase K incubated without pulverization. After 24 h incubation, 90μl AL buffer was added and incubated for another 10 min. The solution was gently pipetted into a mini spin column leaving the cuticle of the specimen which was voucher slide mounted. All voucher specimens were measured and identified beased on morphological feature. All voucher specimens were deposited in the College of Agriculture and Life science, Seoul National University (CALS SNU), the Republic of Korea.

Genes previously used in the aphid phylogeny was chosen in this study (Ortiz-Rivas et al., 2004; von Dohlen et al., 2006; Ortiz-Rivas & Martínez-Torres, 2010; Chen et al., 2015). 4 mitochondrial coding genes: subunit *6 of the mitochondrial F-ATPase* (*ATP6*), *cytochrome oxidase c subunit I* (*COI*), *cytochrome oxidase c subunit II* (*COII*) and *cytochrome oxidase b* (*CytB*) and 1 nuclear coding gene: *elongation factor 1 alpha* (*EF1α*) were selected. 4 mithochondrial genes were chosen to provide resolution at generic and tribal levels and 1 nuclear gene was selected to give subfamily level resolution (Ortiz-Rivas et al., 2004; von Dohlen et al., 2006; Ortiz-Rivas & Martínez-Torres, 2010; Chen et al., 2015).

PCR amplifications were performed with Accupower PCR Premix (Bioneer, Daejeon, Korea) in 20ml reaction mixture. The PCR thermal cycle was followed: 3 min initial denaturation at 95°C, followed by 35 cycles of 95°C for 30-50s, 45-53°C for 30-60s, 68-72°C for 60-90s and a 5-10min final extension at 68-72°C. Primers used in this study and the primer-specific anneling temperature is listed in the table 3.3. Successfully amplified samples were purified using a QIAquick PCR purification kit (Qiagen, Inc.), and then sequenced directly using an automated sequencer (ABI PrismH 3730 XL DNA Analyzer) at Macrogen Inc. (Seoul Korea).

3.2.3. Sequence alignment and modeltest

The dataset used for the analyses contained 654bp of *ATP6*, 657bp of *COI*, 692 of *COII*, 643 of *CytB*, and 772 of *EF1α*, for a total of 3,418bp of sequence. All raw sequences to be analyzed were initially assembled and examined using Seqman pro ver. 7.1.0 (DNA star, Inc., Madison, Wis.). Additionally, I retrieved Genbank reference sequences for the 5 genes, *ATP6*, *COI*, *COII*, *CytB*, and *EF1a* to compare sequences produced present study. Each dataset of 5 genes was aligned using the online utility MAFFT ver. 7 alignment package (Katoh et al., 2013) and MEGA 7 (Kumar et al., 2016) using ClustalW. In this step, uncertain anterior and posterior regions were removed for minimizing the risk of any kind of confusion and error. All sequence dataset were combined using SequenceMatrix ver. 1.7.8 (Vaidya et al., 2010).

3.2.4. Phylogenetic analyses

To test monophyly of Calaphidinae, Bayesian, maximum likelihood, and maximum parsimony analyses for the combined dataset was conducted.

Maximum parsimony analysis (MP) was implemented in Paup 4.0. (Swofford, 1998) using a heuristic search procedure, tree bisection reconnection (TBR) branch swapping, and 1000 random sequence additions with 10 trees held at each pseudoreplicate. All characters were treated as unordered and equally weighted for MP analysis. A thousand MP bootstrap replication were conducted using a heuristic search procedure, with a maximum tree setting of 200 trees.

For the Bayesian phylogenetic analysis (BP), the best-fitted model of nucleotide substitution was selected for each gene with jModelTest ver. 2 (Darriba, 2011). GTR+I+G for *ATP6*, *COI*, *COII*, *CytB*, and *EF1a* were selected. Partitioned BP analysis for the combined dataset was conducted in MrBayes ver. 3.2.2. (Ronquist et al., 2012). For the analyses, four chains (three heated and one cold) were run, starting from a random tree and proceeding for 10 milion Markov Chain Monte Carlo (MCMC) generations, sampling chains every 100th cycle. To ensure that the distribution had stabilized, Tracer ver. 1.4.1. (Rambaut & Drummond, 2008) was used to view the graphical representation of MCMC chanin mixing. Burn-in was set at 20% of the sampled number of trees. Convergence was confirmed by monitoring likelihood values graphically. A 50% majority rule consensus tree was constructed from the remaining trees to estimate posterior probabilities.

For the Maximum Likelihood analysis (ML), best fit nucleotide substitution model was selected using jModelTest ver. 2 (Darriba, 2011). ML analysis was conducted using RaxML ver. 8.2.10 at CIPRES web portal based on GTR+I+G model (Stamatakis, 2014). Branch support for ML analysis was evaluated with 100 bootstrap replications.

3.2.5. Ancestral host plant reconstruction

To infer the ancestral host plant states, Bayesian Binary MCMC was performed (Ronquist & Huelsenbeck, 2003) using RASP ver. 3.2 (Yu et al., 2013).

This is Bayesian inference based approach to infer ancestral states of tree nodes (Ronquist & Huelsenbeck, 2003). Host plants of all ingroup taxa were obtained from reference literatures listed in table 4. MCMC chains were run for 500,000 generations with a sample frequency 100. Burn-in was set at10% of the sampled number of trees. Host plant families were coded for the following: (A) Betulaceae; (B) magnoliaceae; (C) Ulmaceae; (D) Lythraceae; (E) Fabaceae; (F) Poaceae; (G) Fagaceae; (H) Juglandaceae; (I) Tiliaceae; (J) Cannabaceae; (K) Lauraceae (Table 3.4).

3.2.6. Molecular dating

A Bayesian relaxed lognormal clock model was performed with multiple calibration times in BEAST v.2.4.4 (Bouckaert et al., 2014). Fossillized Birth Death model (Heath et al., 2014) was used to simulate speciation. The data was partitioned by genes and GTR+I+G model was applied for each gene. Chains were analysed for 400 milion generations, sampling with every 1000 generation. Traver v.1.6 was used to inspect convergence and mixing of parameters and ESS (Rambaut et al., 2014). TreeAnnotator v.2.4.5 (Bouckaert et al., 2014) was used to summarize mean parameter estimate and 95% highest posterior densitied (HPDs).

Based on fossil records, the most recent common ancestor of Aphidomorpha (Aphidoidea, Adelgoidea, and Phylloxeroidea) was inferred as 120-150 Ma (late Jurassic and early Cretaceous) (Heie, 1987). For the Aphidomorpha crown, normally distributed calibration prior with a mean 135Ma and a standard deviation (SD) of 9.09 Ma was specified. The Aphididae crown was set from 80 to 100Ma based on the previous result of molecular phylogenetic study (von Dohlen & Moran, 2000). Some fossil of the extant Phyllaphidinae species such as †*Glaesaricallis kulickae* Wegierek, 1996, †*Mengeaphis glandulosa* Menge 1856, and †*Wojciechaphis andrei* Wegierek and Kania 2015 were found in Europe with age of 37.2-33.9 Ma (Menge, 1856; Wegierek, 1996; Wegierek & Kania, 2015). Based on these extant species, a uniform distribution (mean: 36 Ma, SD: 2.3) was used for Phyllaphidinae crown. The multiple fossil calibration points are listed in table 3.5.

Table 3.1. Detailed collection information

Subfamily	Tribe	Species	Locality	Date	Plant family	Host plant	Collector
Calaphidinae	CC	*Betacallis alnicolens*	Korea: CN, Okcheon-gun	30.vi.2014	Betulaceae	*Alnus* sp.	Y. Lee
Calaphidinae	CC	*Betacallis* sp.	Korea: GB, Yeongyang-gun, Mt. Ilwol	24.vi.2014	Betulaceae	*Betula* sp.	Y. Lee
Calaphidinae	CC	*Betulaphis quadrituberculata*	Korea: GW, Hwacheon-gun, Haesanryeong	5.vi.2016	Betulaceae	*Betula* sp.	Y. Lee & H. Lee
Calaphidinae	CC	*Betulaphis* sp.	UK: London	10.v.2016	Betulaceae	*Betula* sp.	M. Kanturski
Calaphidinae	CC	*Boernerina occidentalis*	China: Jilin-prov., Mt. Changbaek	22.vi.2009	Betulaceae	unknown	S. Lee
Calaphidinae	CC	*Calaphis magnoliae*	Korea: GG, Icheon-si, Moga-myeon	10.ix.2011	Magnoliaceae	*Magnolia denudata*	Y. Lee
Calaphidinae	CC	*Calaphis similis*	Korea: Seoul, Gwanak-gu, Seoul National University	26.vi.2013	Betulaceae	*Betula platyphylla*	Y. Lee & H. Lee
Calaphidinae	CC	*Calaphis* sp.	USA: California, La Canada Filintridge, Descanso Dr.	20.vii.2015	Betulaceae	*Betula* sp.	Y. Lee & H. Lee
Calaphidinae	CC	*Callipterinella calliptera*	Korea: Seoul, Gwanak-gu, Seoul National University	21.vii.2013	Betulaceae	*Betula platyphylla*	Y. Lee & H. Lee
Calaphidinae	CC	*Clethrobius comes*	Korea: GW, Inje-gun, Bangtae-recreation forest	21.vi.2013	Betulaceae	*Betula costata*	Y. Lee
Calaphidinae	CC	*Euceraphis betulae*	New Zealand	20.xi.2011	Betulaceae	unknown	S. Lee
Calaphidinae	CC	*Euceraphis caerulescens*	Korea: GW, Goseong-gun	4.vi.2014	Betulaceae	*Betula* sp.	Y. Lee & H. Lee
Calaphidinae	CC	*Euceraphis papyrifericola*	Korea: Harbin-prov.	15.viii.2010	Betulaceae	*Betula* sp.	S. Lee
Calaphidinae	CC	*Euceraphis* sp.	China: Jilin-prov., Mt. Changbaek	22.vi.2009	Betulaceae	*Betula* sp.	S. Lee
Calaphidinae	CC	*Neobetulaphis pusilla*	Korea: GW, Taebeak-si, Mt. Hambaek	8.ix.2013	Betulaceae	*Betula* sp.	Y. Lee
Calaphidinae	CC	*Symydobius* (*Symydobius*) sp.	UK: London, Kew Gardens	2.ix.2015	Betulaceae	*Betula sechuanica*	M. Kanturski
Calaphidinae	CC	*Symydobius* (*Yezocallis*) *kabae*	Korea: GG, Icheon-si, Deokpyeong-service area	30.vi.2014	Betulaceae	*Betula* sp.	Y. Lee
Calaphidinae	CM	*Crypturaphis grassii*	UK: Cornwell	1.vii.2011	Betulaceae	*Alnus* sp.	S. Luker
Calaphidinae	CM	*Monaphis antennata*	Poland: Katowice	15.v.2015	Betulaceae	*Betula pendula*	M. Kanturski
Calaphidinae	CM	*Monaphis* sp.	Korea: GW, Hwacheon-gun, Haesanryong	30.v.2015	Betulaceae	*Betula schmidtii*	Y. Lee & H. Lee
Calaphidinae	PM	*Hoplocallis pictus*	Italy: Roma Termini	17.xii.2016	Fagaceae	*Quercus* sp.	Y. Lee & H. Lee
Calaphidinae	PM	*Hoplocallis* sp.1	Iran: Lordegan	3.v.2016	Fagaceae	*Quercus* sp.	M. Walczak
Calaphidinae	PM	*Hoplocallis* sp.2	Iran: Lordegan	3.v.2016	Fagaceae	*Quercus* sp.	M. Walczak
Calaphidinae	PM	*Myzocallis* (*Agrioaphis*) *castanicola*	Italy: Firenze	16.xii.2016	Fagaceae	*Quercus robur*	Y. Lee & H. Lee
Calaphidinae	PM	*Myzocallis* (*Agrioaphis*) sp.	Italy: Firenze	16.xii.2016	Fagaceae	*Castanea sativa*	Y. Lee & H. Lee
Calaphidinae	PM	*Myzocallis* (*Lineomyzocallis*) *walshii*	Czech Republic	22.vii.2004	Fagaceae	unknown	S. Lee

Table 3.1. (Continued)

Subfamily	Tribe	Species	Locality	Date	Plant family	Host plant	Collector
Calaphidinae	PM	*Myzocallis* (*Myzocallis*) *boerneri*	New Zealand	20.xi.2010	Betulaceae	unknown	S. Lee
Calaphidinae	PM	*Myzocallis* (*Myzocallis*) *carpini*	USA: Oregon, Portland, JR. Blvd, Martin Luther King	18.xi.2014	Betulaceae	*Carpinus* sp.	Y. Lee
Calaphidinae	PM	*Myzocallis* (*Myzocallis*) *coryli*	Italy: Firenze	16.xii.2016	Betulaceae	*Corylus avellana*	Y. Lee & H. Lee
Calaphidinae	PM	*Myzocallis* (*Myzocallis*) *occidentalis*	USA: Gorman School Rd 49714	21.vii.2015	Fagaceae	*Quercus* sp.	Y. Lee & H. Lee
Calaphidinae	PM	*Myzocallis* (*Neomyzocallis*) *punctata*	USA: California, Davis, Shields Ave	22.vii.2015	Fagaceae	*Quercus* sp.	Y. Lee & H. Lee
Calaphidinae	PM	*Myzocallis* (*Pasekia*) *persica*	Iran: Lordegan	3.v.2016	Fagaceae	*Quercus* sp.	M. Walczak
Calaphidinae	PM	*Tuberculatus* (*Acanthocallis*) *macrotuberculatus*	Korea: CN, Taean-gun	10.v.2014	Fagaceae	*Quercus dentata*	Y. Lee & H. Lee
Calaphidinae	PM	*Tuberculatus* (*Acanthocallis*) *quercicola*	Korea: Seoul, Gwanak-gu, Seoul National University	16.xi.2013	Fagaceae	*Quercus mongolica*	Y. Lee & H. Lee
Calaphidinae	PM	*Tuberculatus* (*Acanthocallis*) *grisipunctatus*	Korea: Seoul, Gwanak-gu, Seoul National University	5.vi.2016	Fagaceae	*Quercus dntata*	Y. Lee & H. Lee
Calaphidinae	PM	*Tuberculatus* (*Acanthocallis*) sp.	Korea: GG, Yangpyeong-gun, Yongmun-recreation forest	13.vii.2013	Fagaceae	*Quercus aliena*	Y. Lee & H. Lee
Calaphidinae	PM	*Tuberculatus* (*Acanthotuberculatus*) *japonicus*	Korea: Seoul, Gwanak-gu, Seoul National University	28.x.2013	Fagaceae	*Quercus* sp.	Y. Lee & H. Lee
Calaphidinae	PM	*Tuberculatus* (*Acanthotuberculatus*) sp.	Korea: JJ, Jeju-si, Mt. Halla	1.viii.2014	Fagaceae	*Quercus acutissima*	Y. Lee
Calaphidinae	PM	*Tuberculatus* (*Arakawana*) sp.	Korea: GG, Yangju-si, Nam-myeon	21.vii.2008	Fagaceae	*Quercus* sp.	H. Kim
Calaphidinae	PM	*Tuberculatus* (*Arakawana*) *stigmatus*	Korea: Seoul, Gwanak-gu, Seoul National University	26.iv.2014	Fagaceae	*Quercus* sp.	Y. Lee & H. Lee
Calaphidinae	PM	*Tuberculatus* (*Nippocallis*) *kuricola*	Korea: CN, Cheongyang-gun, Mt. Chilgap	10.v.2014	Fagaceae	*Castanea crenata*	Y. Lee & H. Lee
Calaphidinae	PM	*Tuberculatus* (*Nippocallis*) sp.	Korea: GG, Yongin-si, Sinwon-ri	16.v.2014	Fagaceae	*Castanea crenata*	Y. Lee & H. Lee
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) *capitatus*	Korea: Seoul, Gwanak-gu, Seoul National University	14.v.2015	Fagaceae	*Quercus acutissima*	Y. Lee & H. Lee
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) *fangi*	Korea: Seoul, Gwanak-gu, Seoul National University	19.vii.2013	Fagaceae	*Quercus acutissima*	Y. Lee & H. Lee
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) *higuchii* A	Japan: Hokkaido, Iwamizawa	29.vi.2008	Fagaceae	*Quercus crispula*	unknown
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) *higuchii* B	Korea: Seoul, Gwanak-gu, Seoul National University	19.iv.2009	Fagaceae	*Quercus* sp.	H. Kim
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) *higuchii* C	Korea: Seoul, Gwanak-gu, Seoul National University	16.iv.2014	Fagaceae	*Quercus* sp.	Y. Lee & H. Lee
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) *higuchii* D	Korea: GW, Yeongwol-gun, Beobheung-ri	3.vi.2014	Fagaceae	*Quercus* sp.	J.K. Jung
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) *kashiwae*	Korea: Seoul, Gwanak-gu, Seoul National University	28.x.2013	Fagaceae	*Quercus* sp.	Y. Lee & H. Lee

Table 3.1. (Continued)

Subfamily	Tribe	Species	Locality	Date	Plant family	Host plant	Collector
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) *paiki*	Japan: Hokkaido, Bibai	4.ix.2005	Fagaceae	*Quercus dentata*	unknown
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) sp.	Korea: GG, Suwon-si, Mt. Gwanggyo	11.v.2015	Fagaceae	*Quercus aliena*	Y. Lee & H. Lee
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) *yokoyamai*	Korea: GG, Yongin-si, Sinwon-ri	16.v.2014	Fagaceae	*Quercus* sp.	Y. Lee & H. Lee
Calaphidinae	PM	*Tuberculatus* (*Pacificallis*) *californicus*	USA: California, Davis, Shields Ave	22.vii.2015	Fagaceae	*Quercus* sp.	Y. Lee & H. Lee
Calaphidinae	PM	*Tuberculatus* (*Pacificallis*) *columbiae*	USA: California, Davis, Shields Ave	22.vii.2015	Fagaceae	*Quercus* sp.	Y. Lee & H. Lee
Calaphidinae	PM	*Tuberculatus* (*Tuberculatus*) *querceus*	Poland: Katowice	15.v.2015	Fagaceae	*Quercus robur*	M. Kanturski
Calaphidinae	PM	*Tuberculatus* (*Tuberculoides*) *annulatus*	Poland: Piekary Śląskie	16.vi.2015	Fagaceae	*Quercus* sp.	Ł. Depa
Calaphidinae	PM	*Tuberculatus* (*Tuberculoides*) sp.	USA: California, San Marino, Oxford Rd	2.vi.2012	Fagaceae	*Quercus* sp.	Y. Lee
Calaphidinae	PM	*Tuberculatus* (*Tuberculoides*) *eggleri*	Italy: Firenze	16.xii.2016	Fagaceae	*Quercus petraea*	Y. Lee & H. Lee
Calaphidinae	PM	*Tuberculatus* (*Tuberculoides*) *remaudiere*	Poland: Piekary Śląskie	16.vi.2015	Fagaceae	*Quercus* sp.	Ł. Depa
Calaphidinae	PP	*Appendiseta robiniae*	Poland: Piekary Śląskie	5.vi.2016	Fabaceae	*Robinia pseudoacacia*	M. Kanturski
Calaphidinae	PP	*Chromaphis juglandicola*	Korea: CN, Cheonan-si, Cheonan-service area	28.vii.2013	Juglandaceae	*Juglans* sp.	Y. Lee & H. Lee
Calaphidinae	PP	*Chromocallis nirecola*	Korea: Yeongwol-gun, Sangdong-ri	12.vi.2014	Ulmaceae	*Ulmus* sp.	Y. Lee
Calaphidinae	PP	*Dasyaphis rhusae*	Korea: Gwangyang-si, Mt. Beakun	25.vii.2013	Juglandaceae	*Juglans* sp.	Y. Lee
Calaphidinae	PP	*Eucallipterus* sp.	USA: California	v.2003	Tiliaceae	*Tilia* sp.	unknown
Calaphidinae	PP	*Eucallipterus tiliae*	Czech Republic	22.vii.2004	Tiliaceae	*Tilia* sp.	S. Lee
Calaphidinae	PP	*Mesocallis* (*Mesocallis*) *pteleae*	Korea: CN, Cheongyang-gun, Mt. Chilgap	10.v.2014	Betulaceae	*Corylus* sp.	Y. Lee & H. Lee
Calaphidinae	PP	*Mesocallis* (*Mesocallis*) *sawashibae*	Incheon-si, Ganghwa-Island, Mt. Mani	21.vi.2014	Betulaceae	*Carpinus turczaninowii*	Y. Lee & H. Lee
Calaphidinae	PP	*Mesocallis* (*Mesocallis*) sp.	Korea: GN, Goseong-gun, Jangsan-forest	3.v.2015	Betulaceae	*Carpinus laxiflora*	Y. Lee & H. Lee
Calaphidinae	PP	*Mesocallis* (*Paratinocallis*) *corylicola*	Korea: GN, Geoje-Island	14.vii.2014	Betulaceae	*Corylus sieboldiana*	Y. Lee & H. Lee
Calaphidinae	PP	*Mesocallis* (*Paratinocallis*) sp.	Korea: GG, Yongin-si, Sinwon-ri	16.v.2014	Betulaceae	*Corylus heterophylla*	Y. Lee & H. Lee
Calaphidinae	PP	*Neochromaphis carpinicola*	Korea: Incheon-si, Ganghwa-Island, Mt. Mani	21.vi.2014	Betulaceae	*Carpinus turczaninowii*	Y. Lee & H. Lee
Calaphidinae	PP	*Neochromaphis coryli*	Korea: GW, Yeongwol-gun, Nam-myeon, Changwon-ri	12.vi.2014	Betulaceae	*Corylus heterophylla*	Y. Lee
Calaphidinae	PP	*Panaphis juglandis*	Korea: JJ, Jeju-si	13.v.2003	Juglandaceae	*Juglans* sp.	S. Lee
Calaphidinae	PP	*Pseudochromaphis coreana*	Gapyeong-gun, Mt. Hwaya	26.v.2014	Ulmaceae	*Hemiptelea davidii*	Y. Lee
Calaphidinae	PP	*Pterocallis* (*Pterocallis*) *alni*	Czech Republic	22.vii.2004	Betulaceae	*Alnus* sp.	S. Lee

Table 3.1. (Continued)

Subfamily	Tribe	Species	Locality	Date	Plant family	Host plant	Collector
Calaphidinae	PP	*Pterocallis* (*Pterocallis*) *heterophylla*	Korea: GG, Incheon-si, Ganghwa-Island, Mt. Mani	21.vi.2014	Betulaceae	*Carpinus turczaninowii*	Y. Lee & H. Lee
Calaphidinae	PP	*Pterocallis* (*Pterocallis*) sp.	Poland: Katowice	20.v.2016	Betulaceae	*Alnus incana*	M. Kanturski
Calaphidinae	PP	*Pterocallis Recticallis alnijaponicae*	Korea: Seoul, Gwanak-gu, Seoul National University	11.v.2014	Betulaceae	*Alnus hirsuta*	Y. Lee & H. Lee
Calaphidinae	PP	*Pterocallis Recticallis nigrostriata*	Korea: JJ, Jeju-si, Mt. Halla	1.viii.2014	Betulaceae	*Alnus firma*	Y. Lee
Calaphidinae	PP	*Sarucallis kahawaluokalani*	Korea: Seoul, Dongdaemun-gu, Dapsimni-dong	11.vi.2011	Lythraceae	*Lagerstroemia indica*	Y. Lee
Calaphidinae	PP	*Shivaphis* (*Shivaphis*) *celti*	Korea: GG, Suwon-si, SNU-arboretum	30.iv.2014	Cannabaceae	*Celtis* sp.	Y. Lee
Calaphidinae	PP	*Shivaphis* (*Shivaphis*) sp.1	Korea, GN, Is. Ulreung, Ulreung-gun, Bongrae-waterfall	8.vi.2014	Cannabaceae	*Celtis sinensis*	Y. Lee & H. Lee
Calaphidinae	PP	*Shivaphis* (*Shivaphis*) sp.2	Myanmar: Aung Pan city, Ywar-Ngan Township, Taw Kyal Village	19.i.2017	Cannabaceae	*Celtis* sp.	J. Choi
Calaphidinae	PP	*Shivaphis* (*Sinishivaphis*) *szelegiewiczi*	Korea: GW, Yeongwol-gun, Jangreung	24.vi.2014	Cannabaceae	*Celtis* sp.	Y. Lee & H. Lee
Calaphidinae	PP	*Shivaphis* (*Sinishivaphis*) *tilisucta*	Korea: GG, Suwon-si, SNU-arboretum	30.iv.2014	Cannabaceae	*Celtis* sp.	Y. Lee
Calaphidinae	PP	*Takecallis arundicolens*	Korea: JN, Yeosu-si, Odong Island	16.vii.2014	Poaceae	*Pseudosasa japonica*	Y. Lee & H. Lee
Calaphidinae	PP	*Takecallis arundinaliae*	Korea: CN, Taean-gun	10.v.2014	Poaceae	*Sasa* sp.	Y. Lee & H. Lee
Calaphidinae	PP	*Takecallis sasae*	Japan: Iwamizawa, Hokkaido, Japan	10.ix.2005	Poaceae	*Sasa palmata*	Y. Lee & H. Lee
Calaphidinae	PP	*Takecallis* sp.	Korea: JJ, Jeju-si, Mt. Halla	1.viii.2014	Poaceae	*Sasa quelpaertensis*	Y. Lee
Calaphidinae	PP	*Therioaphis* (*Pterocallidium*) *trifolii*	Korea: Seoul, Gwanak-gu, Seoul National University	27.viii.2014	Fabaceae	*Trifolium repens*	Y. Lee & H. Lee
Calaphidinae	PP	*Therioaphis* (*Therioaphis*) *tenera*	Czech Republic	22.vii.2004	Fabaceae	unknown	S. Lee
Calaphidinae	PP	*Tiliaphis coreana*	Korea: GW, Pyeongchang-gun, Byeongnae-ri, Mt. Hwangbyeong	15.viii.2013	Tiliaceae	*Tilia* sp.	Y. Lee
Calaphidinae	PP	*Tiliaphis pseudoshinae*	Gyeonggi-do, Osan-si, Mulhyanggi-arboretum	9.ix.2009	Tiliaceae	*Tilia* sp.	H. Choi
Calaphidinae	PP	*Tiliaphis shinjii*	Korea: GG, Suwon-si	17.vi.2003	Tiliaceae	*Tilia* sp.	H. Kim
Calaphidinae	PP	*Tinocallis* (*Sappocallis*) *saltans*	Korea: GG, Suwon-si	15.v.2003	Ulmaceae	*Ulmus* sp.	S. Kim
Calaphidinae	PP	*Tinocallis* (*Sappocallis*) *takachihoensis*	Korea: GN, Tongyeong-gun	14.vii.2014	Ulmaceae	*Ulmus* sp.	Y. Lee
Calaphidinae	PP	*Tinocallis* (*Sappocallis*) *ulmicola*	Korea: GG, Suwon-si	30.v.2015	Ulmaceae	*Ulmus* sp.	Y. Lee & H. Lee
Calaphidinae	PP	*Tinocallis* (*Tinocallis*) *mushensis*	Korea: CN, Gongju-si, Jeongan-service area	28.vii.2013	Ulmaceae	*Zelkova* sp.	Y. Lee
Calaphidinae	PP	*Tinocallis* (*Tinocallis*) sp.	Korea: GW, Wonju-si, Mt. Chiak	29.viii.2013	Ulmaceae	*Zelkova serrata*	Y. Lee
Calaphidinae	PP	*Tinocallis* (*Tinocallis*) *ulmiparvifoliae*	Korea: GN, Tongyeong-gun	14.vii.2014	Ulmaceae	*Ulmus* sp.	Y. Lee & H. Lee
Calaphidinae	PP	*Tinocallis* (*Tinocallis*) *zelkowae*	Korea: Seoul, Ewha Woman's University	12.v.2013	Ulmaceae	*Zelkova serrata*	Y. Lee

Table 3.1. (Continued)

Subfamily	Tribe	Species	Locality	Date	Plant family	Host plant	Collector
Chaitophorinae	-	*Chaitophorus populeti*	Korea: GW, Inje-gun, Pillye-valley	5.vi.2014	Salicaceae	*Populus tomentiglandulosa*	Y. Lee & H. Lee
Chaitophorinae	-	*Chaitophorus populialbae*	Korea: Seoul, Gwanak-gu, Seoul National University	21.vii.2013	Salicaceae	*Populus* sp.	Y. Lee & H. Lee
Chaitophorinae	-	*Periphyllus koelreuteriae*	Korea: Seoul, Gwanak-gu, Seoul National University	29.iv.2014	Sapindaceae	*Koelreuteria paniculata*	Y. Lee & H. Lee
Lachninae	-	*Cinara sp*	Korea: GW, Yeongwol-gun	18.x.2014	Pinaceae	*Pinus* sp.	Y. Lee
Lachninae	-	*Lachnus tropicallis*	Korea: JN, Gwangyang-si, Chusan-research forest	25.vii.2013	Fagaceae	*Castanea crenata*	Y. Lee
Phyllaphidinae	-	*Diphyllaphis konarae*	Korea: Seoul, Gwanak-gu, Seoul National University	14.v.2015	Fagaceae	*Quercus acutissima*	Y. Lee & H. Lee
Phyllaphidinae	-	*Diphyllaphis quercus*	Korea: CN, Taean-gun	23.viii.2014	Fagaceae	*Quercus acutissima*	Y. Lee & H. Lee
Phyllaphidinae	-	*Machilaphis machili*	Korea: JN, Yeosu-si, Mt. Cheonseon	22.vi.2014	Lauraceae	*Machilus thunbergii*	G. Cho
Phyllaphidinae	-	*Machilaphis* sp.	Myanmar: Ywangan city, Southern Shan State, Federally Main Rd, Shwe Gue Gu Hotel	22.i.2017	Lauraceae	*Machilus* sp.	J. Choi
Phyllaphidinae	-	*Phyllaphis fagi*	UK: Cambridge	15.v.2004	Fagaceae	*Fagus* sp.	unknown
Phyllaphidinae	-	*Phyllaphis fagifoliae*	Korea, GN, Is. Ulreung, Ulreung-gun, Bongrae-waterfall	6.viii.2014	Fagaceae	*Fagus crenata*	Y. Lee & H. Lee
Saltusaphidinae	T	*Allaphis ossiannilssoni*	Korea: GW, Hwacheon-gun, Haesan-ryeong	30.v.2015	Poaceae	*Carex* sp.	Y. Lee & H. Lee
Saltusaphidinae	T	*Thripsaphis ballii caespitosae*	Korea: JJ, Is. Woodo	1.viii.2014	Poaceae	*Carex* sp.	Y. Lee & H. Lee
Saltusaphidinae	T	*Thripsaphis* sp.	China: Jilin-prov., Mt. Changbaek	22.vi.2009	Poaceae	*Carex* sp.	S. Lee

(Abbreviations for tribe, CC, Calaphidini: Calaphidina; CM, Calaphidini: Monaphidina; PM, Panaphidini: Myzocallidina; PP: Panphidini: Panaphidina; T, Thripsaphidini.)

Table 3.2. Accession numbers of each taxa downloaded from Genbank

Family	Subfamily	Species	*ATP6*	*COI*	*COII*	*CytB*	*EF1α*
Aphididae	Aphidinae	*Acyrthosiphon pisum*	AJ298675	KR044798	KT377016	NC_011594	FM174698
Aphididae	Aphidinae	*Aphis gossypii*	KJ669654	KJ669655	KJ669656	KJ669657	EF640162
Aphididae	Aphidinae	*Aphis nerii*	FM174676	KR043466	AM085436	AM085390	FM174700
Aphididae	Aphidinae	*Brachycaudus cardui*	(No data)	KR045222	AY219756	EU189597	JX507484
Aphididae	Aphidinae	*Diuraphis noxia*	NC_022727	NC_022727	NC_022727	NC_022727	DQ005144
Aphididae	Aphidinae	*Pterocomma pilosum*	KC310847	KR536803	GU457807	KR537003	GU457843
Aphididae	Aphidinae	*Rhopalosiphum maidis*	(No data)	GU457793	KT376992	GU457817	JQ860287
Aphididae	Aphidinae	*Rhopalosiphum padi*	AJ298673	KR042889	U36749	HQ528299	FM174699
Aphididae	Aphidinae	*Schizaphis graminum*	AJ298676	KT924253	U36751	GU205372	JF968556
Aphididae	Calaphidinae	*Chromaphis hirsutustibis*	(No data)	JQ920918	(No data)	(No data)	(No data)
Aphididae	Drepanosiphinae	*Drepanaphis parva*	(No data)	KU570449	(No data)	(No data)	KU571722
Aphididae	Drepanosiphinae	*Drepanosiphum oregonensis*	AJ298671	KU570436	(No data)	(No data)	FM174695
Aphididae	Drepanosiphinae	*Drepanosiphum platanoidis*	(No data)	KU570448	(No data)	(No data)	KU571714
Aphididae	Eriosomatinae	*Eriosoma lanigerum*	(No data)	NC_033352	NC_033352	NC_033352	JX627603
Aphididae	Eriosomatinae	*Eriosoma ulmi*	(No data)	JX489652	AM748711	JX489685	JX489718
Aphididae	Lachninae	*Cinara cedri*	(No data)	KJ433268	KM501312	KF694101	FM174683
Aphididae	Lachninae	*Cinara tujafilina*	(No data)	KP339747	KT377013	KF694057	FM174684
Aphididae	Lachninae	*Essigella californica*	(No data)	KM501349	KM501320	KM501382	KM501171
Aphididae	Lachninae	*Eulachnus alticola*	(No data)	JQ916791	JX035378	JX035680	KM501140
Aphididae	Lachninae	*Maculolachnus submacula*	AJ298677	KP869256	JX035085	KP869341	AF163874
Aphididae	Lachninae	*Nippolachnus piri*	(No data)	JX035056	JX035404	JX035700	KM501150
Aphididae	Lachninae	*Tuberolachnus salignus*	(No data)	JX034916	JX035080	JX035437	KM501078
Aphididae	Saltusaphidinae	*Iziphya albipes*	(No data)	GU668621	(No data)	(No data)	(No data)
Aphididae	Saltusaphidinae	*Iziphya flabella*	(No data)	KR039287	(No data)	(No data)	(No data)
Aphididae	Saltusaphidinae	*Subsaltusaphis virginica*	(No data)	EU701913	(No data)	(No data)	(No data)
Aphididae	Saltusaphidinae	*Thripsaphis ballii*	(No data)	EU701927	(No data)	(No data)	(No data)
Aphididae	Saltusaphidinae	*Thripsaphis cyperi*	(No data)	KR045283	(No data)	(No data)	(No data)
Phylloxeridae	Phylloxerininae	*Phylloxerina salicis*	(No data)	JQ920928	JX035119	JX035720	KM501188
Adelgidae	-	*Pineus armandicola*	(No data)	JQ920909	JX035238	JX035721	KM501189

Table 3.3. Primers used in this study

Gene	Primer	Sequence	Annealing temperature	Product Size (bp)	Reference
ATP6	CO2Af	AATCAYAGWTTTATRCCWATTCA	45°C	655	Martinez-Torres et al., 2001
	CO3WWRD	TCWCGAATWACATCWCGTCATCA			
	tRNALysAf2	GACTGAAAAGCAAAGTAATGATCTCT			
COI	LCO1490	GGTCAACAAATCATAAAGATATTGG	45°C	658	Folmer et al., 1994
	HCO2198	TAAACTTCAGGGTGACCAAAAAATCA			
COII	2993	CATTCATATTCAGAATTACC	46°C	531	Stern, 1994
	A3772	GAGACCATTACTTGCTTTCAGTCATCT			
CytB	CP1	GATGATGAAATTTTGGATC	48°C	800	Harry et al., 1998
	CP2	CTAATGCAATAACTCCTCC			
	CB2	ATTACACCTCCTAATTTATTAGGAAT			
EF1α	EF3	GAACGTGAACGTGGTATCAC	53°C	831	von Dohlen et al., 2002
	EF2	ATGTGAGCAGTGTGGCAATCCAA			Palumbi, 1996

Table 3.4. Host plant type coding based on reference literatures for specie

Subfamily	Tribe	Species	Plant order	Plant family (coding)	Reference
Calaphidinae	CC	*Betacallis alnicolens*	Fagales	Betulaceae (A)	Higuchi, 1972; Blackman & Eastop, 2017
Calaphidinae	CC	*Betacallis* sp.	Fagales	Betulaceae (A)	This study; Blackman & Eastop, 2017
Calaphidinae	CC	*Betulaphis quadrituberculata*	Fagales	Betulaceae (A)	Blackman & Eastop, 2017
Calaphidinae	CC	*Betulaphis* sp.	Fagales	Betulaceae (A)	This study
Calaphidinae	CC	*Boernerina occidentalis*	Fagales	Betulaceae (A)	Blackman & Eastop, 2017
Calaphidinae	CC	*Calaphis magnoliae*	Magnoliales	Magnoliaceae (B)	Higuchi, 1972; Blackman & Eastop, 2017
Calaphidinae	CC	*Calaphis similis*	Fagales	Betulaceae (A)	Quednau, 1979; Blackman & Eastop, 2017
Calaphidinae	CC	*Calaphis* sp.	Fagales	Betulaceae (A)	This study
Calaphidinae	CC	*Callipterinella calliptera*	Fagales	Betulaceae (A)	Higuchi, 1972; Blackman & Eastop, 2017
Calaphidinae	CC	*Clethrobius comes*	Fagales	Betulaceae (A)	Higuchi, 1972; Blackman & Eastop, 2017
Calaphidinae	CC	*Euceraphis betulae*	Fagales	Betulaceae (A)	Blackman, 2002; Blackman & Eastop, 2017
Calaphidinae	CC	*Euceraphis caerulescens*	Fagales	Betulaceae (A)	Blackman, 2002; Blackman & Eastop, 2017
Calaphidinae	CC	*Euceraphis papyrifericola*	Fagales	Betulaceae (A)	Blackman, 2002; Blackman & Eastop, 2017
Calaphidinae	CC	*Euceraphis* sp.	Fagales	Betulaceae (A)	This study
Calaphidinae	CC	*Neobetulaphis pusilla*	Fagales	Betulaceae (A)	Basu, 1964; Blackman & Eastop, 2017
Calaphidinae	CC	*Symydobius* (*Symydobius*) sp.	Fagales	Betulaceae (A)	This study
Calaphidinae	CC	*Symydobius* (*Yezocallis*) *kabae*	Fagales	Betulaceae (A)	Higuchi, 1972; Blackman & Eastop, 2017
Calaphidinae	CM	*Crypturaphis grassii*	Fagales	Betulaceae (A)	Blackman & Eastop, 2017
Calaphidinae	CM	*Monaphis antennata*	Fagales	Betulaceae (A)	Higuchi, 1972 Higuchii, 1972
Calaphidinae	CM	*Monaphis* sp.	Fagales	Betulaceae (A)	This study
Calaphidinae	PM	*Hoplocallis pictus*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Hoplocallis* sp.1	Fagales	Fagaceae (G)	This study
Calaphidinae	PM	*Hoplocallis* sp.2	Fagales	Fagaceae (G)	This study
Calaphidinae	PM	*Myzocallis* (*Agrioaphis*) *castanicola*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Myzocallis* (*Agrioaphis*) sp.	Fagales	Fagaceae (G)	This study
Calaphidinae	PM	*Myzocallis* (*Lineomyzocallis*) *walshii*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Myzocallis* (*Myzocallis*) *boerneri*	Fagales	Betulaceae (A)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Myzocallis* (*Myzocallis*) *carpini*	Fagales	Betulaceae (A)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Myzocallis* (*Myzocallis*) *coryli*	Fagales	Betulaceae (A)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Myzocallis* (*Myzocallis*) *occidentalis*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Myzocallis* (*Neomyzocallis*) *punctata*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Myzocallis* (*Pasekia*) *persica*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Acanthocallis*) *macrotuberculatus*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Acanthocallis*) *quercicola*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Acanthocallis*) *grisipunctatus*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Acanthocallis*) sp.	Fagales	Fagaceae (G)	This study
Calaphidinae	PM	*Tuberculatus* (*Acanthotuberculatus*) *japonicus*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Acanthotuberculatus*) sp.	Fagales	Fagaceae (G)	This study
Calaphidinae	PM	*Tuberculatus* (*Arakawana*) sp.	Fagales	Fagaceae (G)	This study
Calaphidinae	PM	*Tuberculatus* (*Arakawana*) *stigmatus*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Nippocallis*) *kuricola*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Nippocallis*) sp.	Fagales	Fagaceae (G)	This study

Table 3.4. (continued)

Subfamily	Tribe	Species	Plant order	Plant family (coding)	Reference
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) *capitatus*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) *fangi*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) *higuchii* A	Fagales	Fagaceae (G)	Yao, 2011; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) *higuchii* B	Fagales	Fagaceae (G)	Yao, 2011; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) *higuchii* C	Fagales	Fagaceae (G)	This study
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) *higuchii* D	Fagales	Fagaceae (G)	This study
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) *kashiwae*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) *paiki*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) sp.	Fagales	Fagaceae (G)	This study
Calaphidinae	PM	*Tuberculatus* (*Orientuberculoides*) *yokoyamai*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Pacificallis*) *californicus*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Pacificallis*) *columbiae*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Tuberculatus*) *querceus*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Tuberculoides*) *annulatus*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Tuberculoides*) sp.	Fagales	Fagaceae (G)	This study
Calaphidinae	PM	*Tuberculatus* (*Tuberculoides*) *eggleri*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PM	*Tuberculatus* (*Tuberculoides*) *remaudiere*	Fagales	Fagaceae (G)	Quednau, 1999; Blackman & Eastop, 2017
Calaphidinae	PP	*Appendiseta robiniae*	Fabales	Fabaceae (E)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Chromaphis juglandicola*	Fagales	Juglandaceae (H)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Chromaphis hirsutustibis*	Fagales	Juglandaceae (H)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Chromocallis nirecola*	Rosales	Ulmaceae (C)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Dasyaphis rhusae*	Fagales	Juglandaceae (H)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Eucallipterus* sp.	Malvales	Tiliaceae (I)	This study
Calaphidinae	PP	*Eucallipterus tiliae*	Malvales	Tiliaceae (I)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Mesocallis* (*Mesocallis*) *pteleae*	Fagales	Betulaceae (A)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Mesocallis* (*Mesocallis*) *sawashibae*	Fagales	Betulaceae (A)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Mesocallis* (*Mesocallis*) sp.	Fagales	Betulaceae (A)	This study
Calaphidinae	PP	*Mesocallis* (*Paratinocallis*) *corylicola*	Fagales	Betulaceae (A)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Mesocallis* (*Paratinocallis*) sp.	Fagales	Betulaceae (A)	This study
Calaphidinae	PP	*Neochromaphis carpinicola*	Fagales	Betulaceae (A)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Neochromaphis coryli*	Fagales	Betulaceae (A)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Panaphis juglandis*	Fagales	Juglandaceae (H)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Pseudochromaphis coreana*	Rosales	Ulmaceae (C)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Pterocallis* (*Pterocallis*) *alni*	Fagales	Betulaceae (A)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Pterocallis* (*Pterocallis*) *heterophylla*	Fagales	Betulaceae (A)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Pterocallis* (*Pterocallis*) sp.	Fagales	Betulaceae (A)	This study
Calaphidinae	PP	*Pterocallis* (*Recticallis*) *alnijaponicae*	Fagales	Betulaceae (A)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Pterocallis* (*Recticallis*) *nigrostriata*	Fagales	Betulaceae (A)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Sarucallis kahawaluokalani*	Myrtales	Lythraceae (D)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Shivaphis* (*Shivaphis*) *celti*	Rosales	Cannabaceae (J)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Shivaphis* (*Shivaphis*) sp.1	Rosales	Cannabaceae (J)	This study
Calaphidinae	PP	*Shivaphis* (*Shivaphis*) sp.2	Rosales	Cannabaceae (J)	This study

Table 3.4. (continued)

Subfamily	Tribe	Species	Plant order	Plant family (coding)	Reference
Calaphidinae	PP	*Shivaphis* (*Sinishivaphis*) *szelegiewiczi*	Rosales	Cannabaceae (J)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Shivaphis* (*Sinishivaphis*) *tilisucta*	Rosales	Cannabaceae (J)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Takecallis arundicolens*	Poales	Poaceae (F)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Takecallis arundinaliae*	Poales	Poaceae (F)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Takecallis sasae*	Poales	Poaceae (F)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Takecallis* sp.	Poales	Poaceae (F)	This study
Calaphidinae	PP	*Therioaphis* (*Pterocallidium*) *trifolii*	Fabales	Fabaceae (E)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Therioaphis* (*Therioaphis*) *tenera*	Fabales	Fabaceae (E)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Tiliaphis coreana*	Malvales	Tiliaceae (I)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Tiliaphis pseudoshinae*	Malvales	Tiliaceae (I)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Tiliaphis shinjii*	Malvales	Tiliaceae (I)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Tinocallis* (*Sappocallis*) *saltans*	Rosales	Ulmaceae (C)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Tinocallis* (*Sappocallis*) *takachihoensis*	Rosales	Ulmaceae (C)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Tinocallis* (*Sappocallis*) *ulmicola*	Rosales	Ulmaceae (C)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Tinocallis* (*Tinocallis*) *mushensis*	Rosales	Ulmaceae (C)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Tinocallis* (*Tinocallis*) sp.	Rosales	Ulmaceae (C)	This study
Calaphidinae	PP	*Tinocallis* (*Tinocallis*) *ulmiparvifoliae*	Rosales	Ulmaceae (C)	Quednau, 2003; Blackman & Eastop, 2017
Calaphidinae	PP	*Tinocallis* (*Tinocallis*) *zelkowae*	Rosales	Ulmaceae (C)	Quednau, 2003; Blackman & Eastop, 2017
Phyllaphidinae	-	*Diphyllaphis konarae*	Fagales	Fagaceae (G)	Quednau, 2010; Blackman & Eastop, 2017
Phyllaphidinae	-	*Diphyllaphis quercus*	Fagales	Fagaceae (G)	Quednau, 2010; Blackman & Eastop, 2017
Phyllaphidinae	-	*Machilaphis machili*	Laurales	Lauraceae (K)	Quednau, 2010; Blackman & Eastop, 2017
Phyllaphidinae	-	*Machilaphis* sp.	Laurales	Lauraceae (K)	This study
Phyllaphidinae	-	*Phyllaphis fagi*	Fagales	Fagaceae (G)	Quednau, 2010; Blackman & Eastop, 2017
Phyllaphidinae	-	*Phyllaphis fagifoliae*	Fagales	Fagaceae (G)	Quednau, 2010; Blackman & Eastop, 2017
Saltusaphidinae	S	*Iziphya albipes*	Poales	Poaceae (F)	Quednau, 2010; Blackman & Eastop, 2017
Saltusaphidinae	S	*Iziphya flabella*	Poales	Poaceae (F)	Quednau, 2010; Blackman & Eastop, 2017
Saltusaphidinae	T	*Allaphis ossiannilssoni*	Poales	Poaceae (F)	Quednau, 2010; Blackman & Eastop, 2017
Saltusaphidinae	T	*Subsaltusaphis virginica*	Poales	Poaceae (F)	Quednau, 2010; Blackman & Eastop, 2017
Saltusaphidinae	T	*Thripsaphis ballii*	Poales	Poaceae (F)	Quednau, 2010; Blackman & Eastop, 2017
Saltusaphidinae	T	*Thripsaphis ballii caespitosae*	Poales	Poaceae (F)	Quednau, 2010; Blackman & Eastop, 2017
Saltusaphidinae	T	*Thripsaphis cyperi*	Poales	Poaceae (F)	Quednau, 2010; Blackman & Eastop, 2017
Saltusaphidinae	T	*Thripsaphis* sp.	Poales	Poaceae (F)	This study

(Abbreviations for tribe, CC, Calaphidini: Calaphidina; CM, Calaphidini: Monaphidina; PM, Panaphidini: Myzocallidina; PP: Panphidini: Panaphidina; T, Thripsaphidini.)

Table 3.5. Time calibration points

Taxon	Age (Ma)	Source	References
Aphidomorpha	120 - 150	Fossil	Heie, 1987
Aphididae	80 - 100	Time-calibration	Von Dohlen & Moran, 2000
		Fossil	Heie, 1987; 1999; Heie & Wegierek, 2011
Aphidinae	60.0 - 80.0	Fossil	Heie, 1987
Drepanisiphinae	94.3-13.6	Fossil	Lutz, 1985; Zhang & Hong, 1999; Heie 2006; Heie & Wegierek, 2011
Eriosomatini	37.2 - 5.3	Fossil	Rebel, 1898; Meunier, 1914; Heie, 1967
Lachninae	16.0 - 7.2	Fossil	Rebel, 1898; Heie & Wegierek, 2011
Phyllaphidinae	37.2 - 33.9	Fossil	Wegierek & Kania, 2015
Saltusaphidinae	37.2 - 33.9	Fossil	Heie, 1967; Heie & Wegierek, 2011

3.3. Results

3.3.1. Tree topology from combined dataset

The tree resulting from Bayesian (BP), maximum likelihood (ML), and maximum parsimony (MP) analyses for the combined dataset were shown in Fig. 3.2. The MP tree (Fig. 3.2, A) was different from the topologies produced by BP (Fig. 3.2, B) and ML analyses (Fig. 3.2, C) in regard to the positions of some genera *Crypturaphis*, *Eucallipterus*, *Iziphya*, *Pseudochromaphis*, *Shivaphis*, *Symydobius*, and *Tiliaphis*. However, BP and ML analyses produced almost identical topologies. However, position of some species (*Tinocallis ulmiparvifoliae*, *Tuberculatus capitatus*, *Tu*. *fangi*, and *Tu*. *yokoyamai*) were differed between BP and ML analyses. However, in the topologies produced in three analyses, monophyly of Phyllaphidinae and Calaphidini were was well supported. The monophyly of Saltusaphidinae was not supported in MP analyses (Fig. 3.2, A).

3.3.2. Phylogenetic results

Phyllaphidinae formed a basal node of Calaphidinae *s.l.* with a high supporting values (Fig. 3.3, node A, MP bootstrap, MP = 99, Posterior probability, PP= 0.94, Bootstrap percentage, BP= 94).

The monophyly of Calaphidinae *s.s.* was not supported in all three analyses. MP, BP and ML analyses showed that Saltusaphidinae was clearly nested within Calaphidinae *s.s.* by forming a sister clade of Panaphidina species: *Appendiseta robiniae*, *Chromocallis nirecola*, *Sarucallis*, *Takecallis*, *Therioaphis*, and

Tinocallis (Figs 3.3, node P, PP = 0.72, BP = 41). However, in MP analysis, the genus *Izyphya* was separated from other Saltusaphidnae species (Fig. 3.2, A).

Tribe Calaphidini was monophyletic with a high support values (Fig. 3.3, node B, MP= 78, PP= 0.94, BP= 84,) in MP, BP and ML trees. However, two subtribes, Calaphidina and Monaphidina, were not monophyly in BP and ML (Fig. 3.3, node C, PP= 0.94, BP= 69). Two genera of Monaphidina, *Monaphis* (Fig. 3.3, node D) and *Crypturaphis* (Fig. 3.3, node F), were separated in both BP and ML results (Fig. 3.2). In MP analysis, Monaphidina formed a monophyly (Fig. 3.2, MP= 71). The genus *Callipterinella* was nested within the genus *Calaphis* (Fig. 3.3, node E) with a strong support values (MP= 100, PP= 0.99, BP= 80). The genus *Euceraphis* was paraphyletic and claded with *Clethrobius* and *Symydobius* under MP, BP and ML trees (Fig. 3.3, node G).

The tribe Panaphidini was highly paraphyletic in MP, BP and ML results (Fig. 3.2). *Dasyaphis*, *Mesocallis*, *Neochromaphis*, and *Pterocallis* formed a basal node of Papaphidini (Fig. 3.3, node H, MP= 97, PP= 0.90, BP= 77).

Pseudochromaphis coreana formed a distinct clade with strong support values (Fig. 3, node J, BP= 91, PP= 1.0). However, in MP analysis, this genus was claded with *Tuberculatus* (*Pacificallis*) *californicus* (Fig. 3.2, A).

Chromaphis, *Eucallipterus*, *Panaphis*, *Shivaphis*, and *Tiliaphis* formed a third clade of Panaphidini with high support values in BP and ML analyses (Fig. 3.3, node K, PP= 0.91, BP= 87). However, in MP tree, *Shivaphis* and *Tiliaphis* and other genera were separated. Saltusaphidinae

Saltusaphidinae and rest of genera in Panaphidina (*Appendiseta*, *Chromocallis*, *Sarucallis*, *Takecallis*, *Therioaphis*, and *Tinocallis*) formed the last clade (Fig. 3.3, node O). Although the supporting value of this node was very low in ML analysis (BP= 41), BP analysis supported highly supported this node (PP= 0.91). The node position of *Appendiseta robiniae* and *Sarucallis kahawaluokalani* was differ between BP and ML trees (Fig. 3.3, node R). In ML tree, this clade was located between *Therioaphis* (Fig. 3.3, node S) and *Takecallis* (Fig. 3.3, node U, BP= 77). However, in BP tree, positions of *A. robiniae* and *S. kahawaluokalani* clade (PP= 0.35) and *Takecallis* clade (PP= 0.97) wer switched (Fig. 3.2). The porition of *Tinocallis ulmiparvifoliae* was discondance in all three analyses.

Subtribe Myzocallidina formed monophyletic clade with an almost same node positions in BP and ML analyses with a high support values (Fig. 3.3, node T, PP= 0.96, BP= 95). *Tuberculatus* (*Pacificallis*) *californicus* formed independent clade (Fig. 3.3, node U). Two largest genera of Myzocallidina, *Myzocallis* and *Tuberculatus*, were not monophyly under all analyses (Fig. 3.3, node V, MP= 75, PP= 0.97, BP= 43). *Hoplocallis* was nested within *Myzocallis* group (PP= 0.94, BP= 47). Subgenus *Tuberculatus* was claded with subgenus *Nippocallis* with a strong support values (Fig. 3.3, node W, MP= 100, PP= 0.97, BP= 95). Subgenus *Orientuberculoides* was not a monophyly by separating two species, *Tuberculatus* (*Orientuberculoides*) *capitatus* and *T.* (*O.*) *fangi* from the main clade of other species of *Orientuberculoides* (Fig. 3.3, node X).

3.3.3. Ancestral host plant reconstruction

The ancestral host plant association of Calaphidinae *s.l.* is shown in Fig. 3.4. 11 host plant families associated with each species of Calaphidinae *s.l.* were coded as A to K (Table 3.4) in Bayesian Binary MCMC analysis (BBM). In the results, Fagaceae have the highest probability of being the ancestral host for the basal node of Calaphidinae *s.l.* (Fig. 3.4, node A, BBM= 0.78). For the Calaphidini (Fig. 3.4, node B, BBM= 0.96) and early diverging Panaphidini (Fig. 3.4, node C, BBM= 0.93), Betulaceae was highly favored as ancestral host. Ulmaceae was shown as the ancestral state for *Peudochromaphis coreana* (Fig. 3.4, node G, BBM= 0.64). However, ancestral state of lately diverging Panaphidina was uncertain (Fig. 3.4, node F). Betulaceae, Canabaceae, Fagaceae, Poaceae, Tiliaceae, and Ulmaceae were proposed as possible ancestral host plant of this node. Among these host plant families, the possibility of Fagaceae was slightly higher than other plant families (BBM= 0.26). For the Saltusaphidinae, Poaceae was favoured as ancestral host plant (Fig. 3.4, node G, BBM= 0.52). For the node H, Fabaceae, Poaceae, and Ulmaceae showed similar possibility values. Fagaceae was strongly proposed as the ancestral host as Myzocallidina (Fig. 3.3, node I).

3.3.4. Molecular dating

The most recent common ancestor of Calaphidinae *s.s.* dates to about 83.5 Ma (95% HPD= 78.3-92.2 Ma), during the late Cretaceous (Fig. 3.5). The Phyllaphidinae crown was estimated to have arisen at 87.3 Ma (95% HPD= 79.9-94.6 Ma) and the mean age of Saltusaphidinae was 58.1 Ma (95% HPD= 54.1-64.2 Ma). In the Calaphidinae *s.l.*, most genera could arise between late Cretaceous to Oligocene. From Eocene to Oligocene, species level divergence can be occurred.

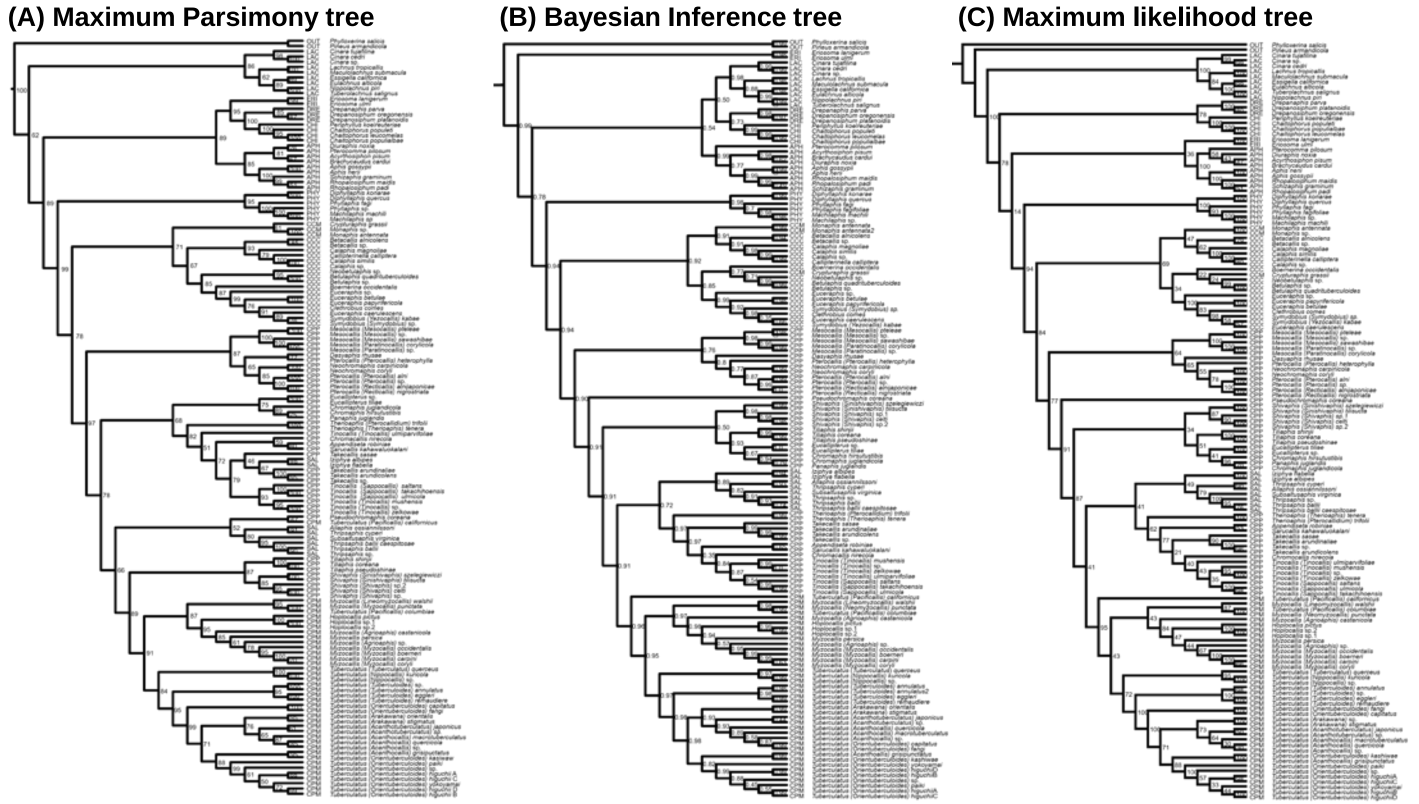

Fig. 3.2. Phylogenetic trees of combined dataset. (A) Maximum parsimony tree, The numbers on the right side of nodes are bootstrap percentages (%), (B) Bayesian phylogenetic tree, The numbers on the right side of nodes are posterior probability values (%), (C) Maximum likelihood tree. The numbers on the right side of nodes are bootstrap percentages (%). Symbols at the terminal branches indicate abbreviations as follows: APH, Aphidinae; CHI, Chaitophorinae; CCC, Calaphidinae: Calaphidini: Calaphidina; CCM, Calaphidinae: Calaphidini: Monaphidina; CPM, Calaphidinae: Panaphidini: Myzocallidina; CPM, Calaphidinae: Panaphidini: Panaphidina; DRE, Drepanosiphinae; ERI, Eriosomatinae; LAC, Lachninae; PHY, Phyllaphidinae; SAL, Saltusaphidinae.

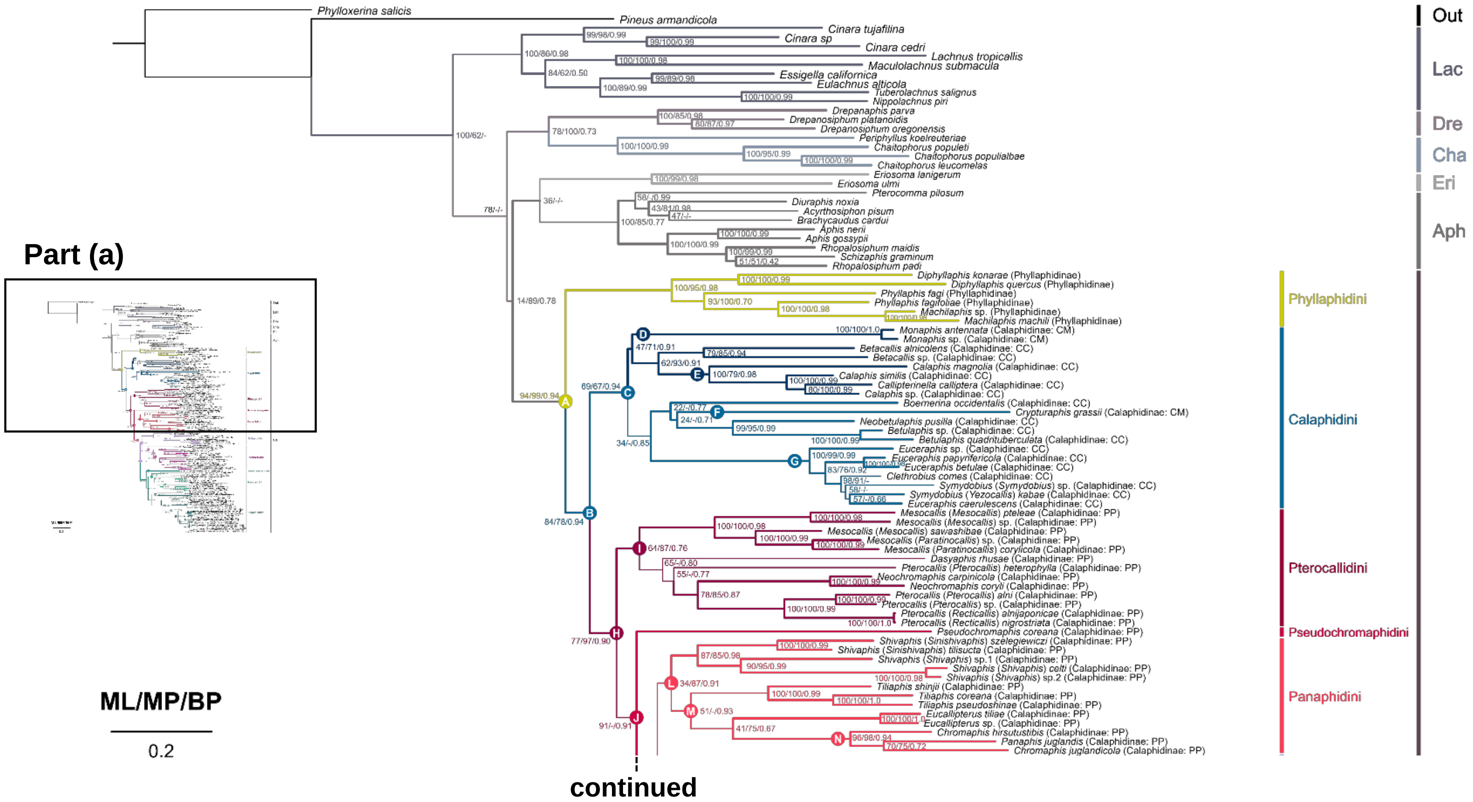

Fig. 3.3. Part (a). Phylogenetic relationship from Maximum likelihood analysis. Numbers near the branches are MP bootstrap percentage (%), ML bootstrap percentages (%) and Bayesian posterior probabilities. The family and subfamily names in brackets follows Nieto Nafria, 2011. Thick branches indicate nodes recovered in the BP analysis. Capitals on the node refer to nodes discussed in the text. Abbreviations for subfamilies, tribes and subtribes: Aph, Aphidinae; Cal, Calaphidinae; Chi, Chaitophorinae; Dre, Drepanosiphinae; Eri, Eriosomatinae; Lac, Lachninae; CC, Calaphidini: Calaphidina; CM, Calaphidini: Monaphidina; PM, Panaphidini: Myzocallidina; PP: Panphidini: Panaphidina; T, Thripsaphidini. Phylogenetic reconstruction by the results of present study indicated the right in column.

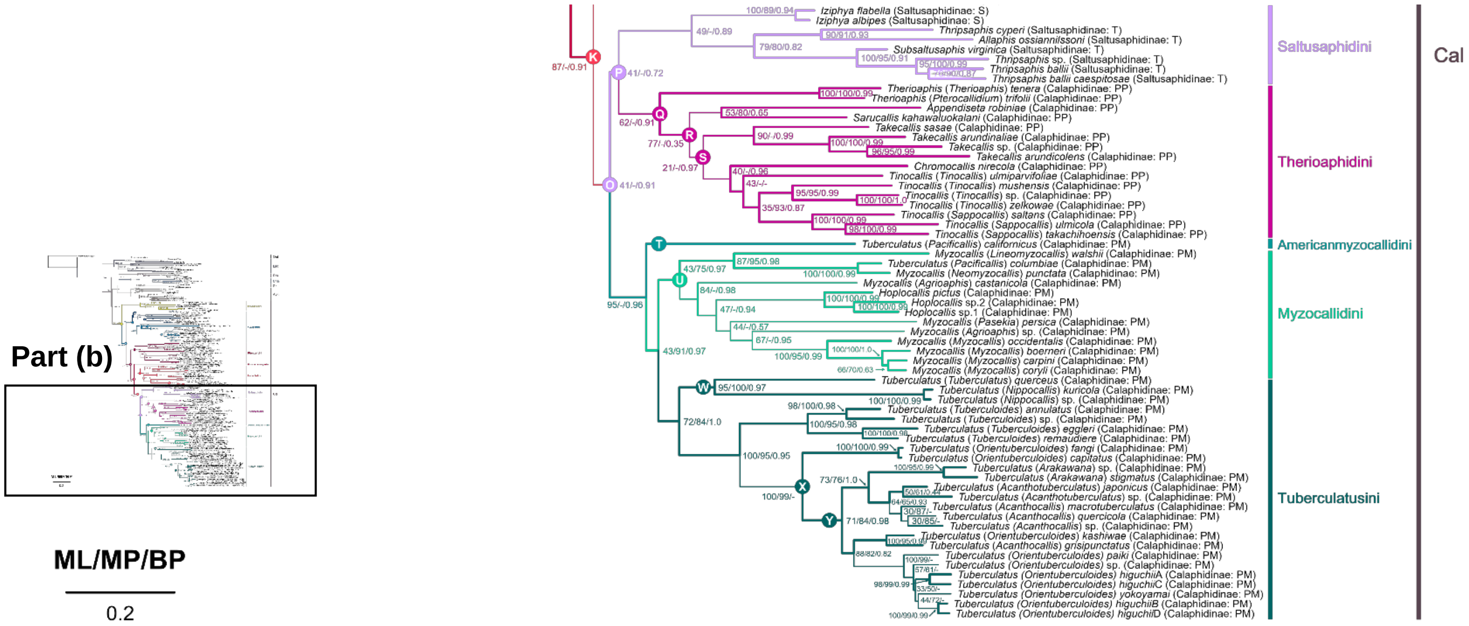

Fig. 3.3. Part (a). Phylogenetic relationship from Maximum likelihood analysis. Numbers near the branches are MP bootstrap percentage (%), ML bootstrap percentages (%) and Bayesian posterior probabilities. The family and subfamily names in brackets follows Nieto Nafria, 2011. Thick branches indicate nodes recovered in the BP analysis. Capitals on the node refer to nodes discussed in the text. Abbreviations for subfamilies, tribes and subtribes: PM, Panaphidini: Myzocallidina; PP: Panphidini: Panaphidina; T, Thripsaphidini. Phylogenetic reconstruction by the results of present study indicated the right in column.

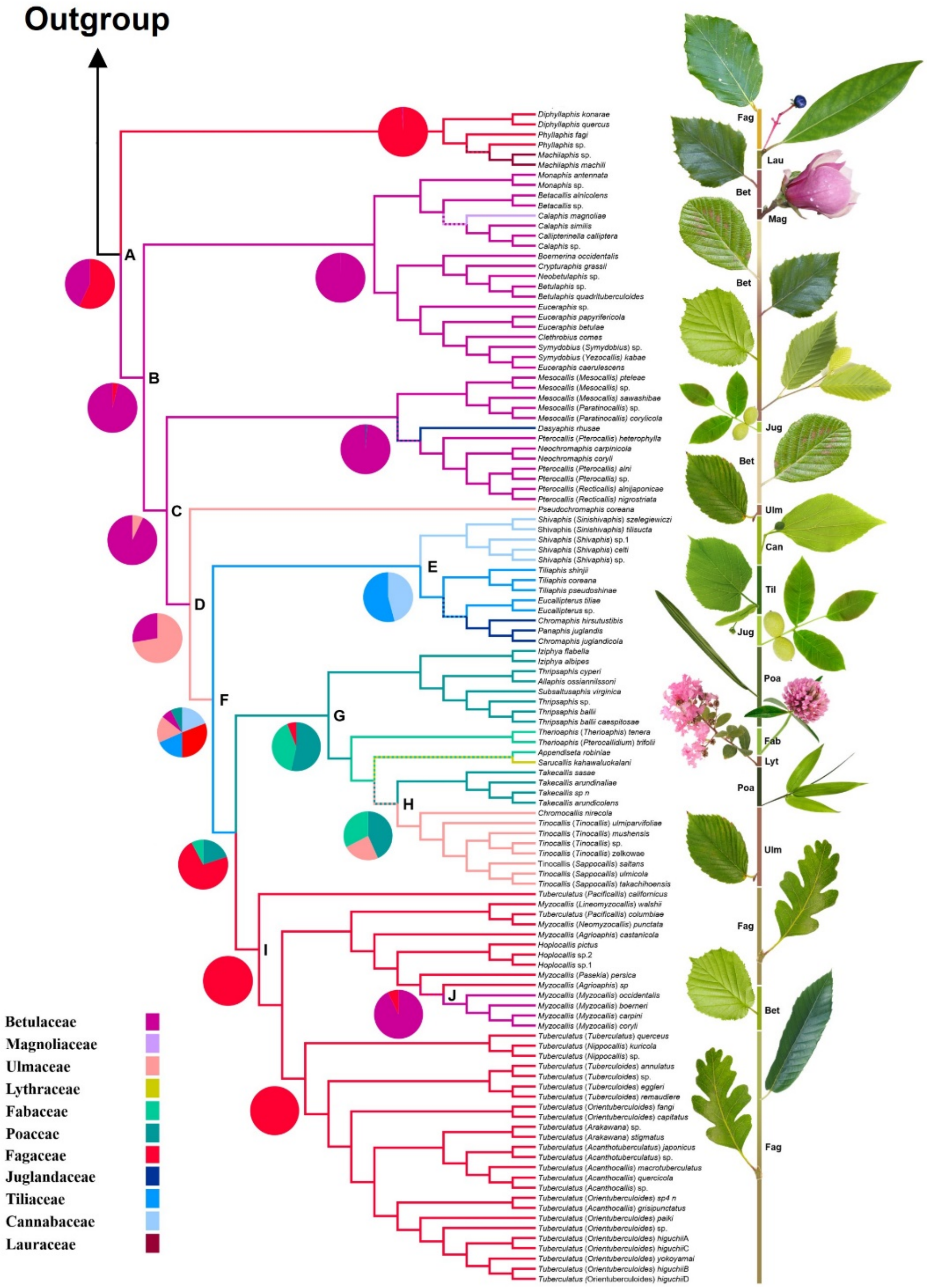

Fig. 3.4. Host plant reconstruction based on Bayesian Binary MCMC analyses as implemented from the RASP ver. 3.2. Ancestral host use is indicated as colored pie charts near the node. Capital letters on the node refer to nodes discussed in the text. Abbreviations for plant families, Bet, Betulaceae; Can, Cannabaceae; Fab, Fabaceae; Fag, Fagaceae; Jug, Juglandaceae; Lau, Lauraceae; Lyt, Lythraceae; Mag, Magnoliaceae; Poa, Poaceae; Til, Tiliaceae; Ulm, Ulmaceae.

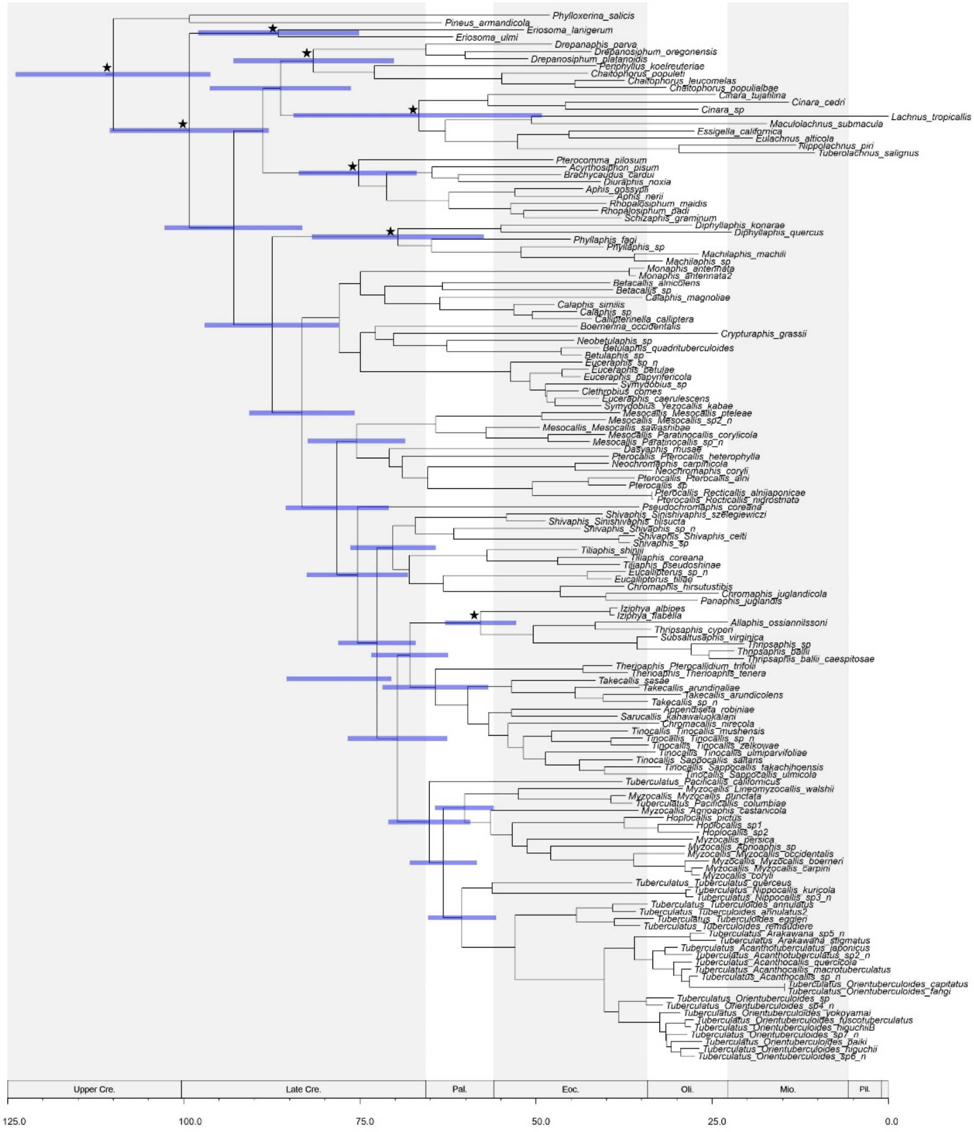

Fig. 3.5. Phylogram of Calaphidinae *s. lat*. time calibrated with BEAST v.2.4.4. Asterisks indicate time calibration points (Table 3.5). Date ranges for key nodes are presented with purple lines.

3.4. Discussion

Until now, no extensive molecular phylogenetic analyses have been done for Calaphidinae *s.l.* This is the first comprehensive molecular phylogeny of this group. In the phylogenetic analyses of the combined dataset of four mitochondrial and one nuclear gene showed that, Calaphidinae *s.s.* is not a monophyletic and most relationships were roughly similar in MP, ML and BP analyses. Except for MP analysis, ML and BP analyses confirmed ten well supported clades of Calaphidinae *s.l.* (Fig. 3.3).

In the present study, phylogenetic relationship between Calaphidinae *s.s.* and Phyllaphidinae was revealed for the first time. Phyllaphidinae formed a basal node as the most primitive group of Calaphidinae *s.l.* with high supporting values (Fig. 3.3, node A). In Novakova et al. (2013), only one phyllaphidine species (*Phyllaphis grandifoliae*) was used for the phylogenetic analyses and this species was closely claded with Calaphidinae clade. However, only with the one species, Novakova et al. (2013) couldn't discuss on the relationship of Phyllaphidinae and Calaphidinae *s.s.*

The nesting of Saltusaphidinae within Panaphidina was recovered with much greater number of species in this study. In the von Dohlen and Moran (2000) and Novakova et al. (2013), also recovered this relationship. Although the lack of high branch support value in ML analysis, BP result highly supported this relationship. This subfamilies has undergone considerable taxon level changes with a lot of controversy (see part I historical review). More recent years, Wieczorek et al. (2011) argued that there is no conspicuous differences between Calaphidinae, Phyllaphidinae, and Saltusaphidinae based on the comparative study of aphid male genitalia. They also shown that Calaphidinae group is closely related with Aphidinae, Chaitophorinae and Drepanosiphinae by having normal sized males without modified external genitalia (Wieczorek et al., 2011). Wieczorek et al.'s study (2011) is highly congruent of the present study.

Moreover, in terms of host plant relationship of Phyllaphidinae, its molecular phylogenetic position is quite meaningful. Most phyllaphidine aphids are associated with Fagaceae which is one of the plant families under the plant order Fagales together with Betulaceae. Ancestral state reconstruction results showed that, Betulaceae is proposed as an ancestral host of Calaphidini and early diverging Panaphidini group which was the closest sister clade of Phyllaphidinae (Fig. 3.4, node B, C). These results may suggest that primitive groups of Calaphidinae *s.l.* could be associated with Fagales group and host plant shifting from Fagaceae to Betulaceae within Fagales might lead a divergence of Calaphidini.

Although, the monophyly of the tribe Calaphidini was highly supported in all analyses, subtribes Monaphidina and Calaphidina was paraphyletic. *Monaphis*, the type genus of Monaphidina, and *Calaphis*, the type genus of Calaphidina, *Betacallis*, and *Callipterinella* were came under the same clade. *Crypturaphis* (Monaphidina) and *Betulaphis*, *Boernerina*, *Clethrobius*, *Euceraphis*, *Neobetulaphis*, and *Symydobius* (Calaphidina) formed another clade within Calaphidini. Morphologically, these clades can be separatd by the ratio of the processus terminalis and the basal part of the 6th antennal segment.

Interestingly, species of the early diverged Panaphidini group (Fig. 3.3, node H) was also associated with host plants belonging to Betulaceae though, they never occur on *Betula* spp. This may suggest that host plant range broadening within the Betulaceae may be associated with the early radiation of Calaphidinae *s.s.* *Juglans* (Fagales: Juglandaceae) feeding species *Dasyaphis rhusae* was nested within *Mesocallis*+*Neochromaphis*+*Pterocallis* clade (Fig. 3.3, node I). In Quednau (2003)'s view, *Dasyaphis* group has been treated as the most primitive genus in Panaphidini. However, his assumption was not supported in the present study. Morphological features of these genera have in common by having spinulous hairs in embryonic period.

The monotypic genus *Pseudochromaphis* formed an independent clade (Fig. 3.3, node J). Morphologically, this genus is considered as *Sinochaitophorus* group. Morphologically, species of this group have conspicuous cone shaped median protrusion on a head and unique patterns on fore wing (Quednau, 2003). Although in the present study, species of *Sinochaitophorus* were not tested, this genus can be tied with *Pseudochromaphis*. Their host plant association with *Ulmus* and Asian distribution also can be a supporting evidence (Quednau, 2003). However, this assumption requires further analyses. Divergence of *Pseudochromaphis* (Fig. 3.3, node J) may suggest that the first host plant shifting from Fagales to Rosales may draw a second tribal divergence.

Host plant afiliation with Canabaceae (Rosales) of *Shivaphis* group may indicate that after the first plant order level shifting from Fagales to Rosales, the consequence host plant broadening within Rosales brought the next tribal level divergences (Fig. 3.4). In BP and ML analyses, *Shivaphis* spp. were claded with *Eucallipterus*+*Tiliaphis*+*Chromaphis*+*Panaphis* clade at node L (Fig. 3.3). These genera can be grouped by having much longer length of 8th abdominal dorsal setae than those of marginal setae in theirs embryonic period. According to Quednau (2003), this genus has been regarded to have close relationship with three Poaceae feeding gerera (*Chuansicallis*, *Neocranaphis* and *Phyllaphoides*) by having flat marginal elevations, very short and poriform SIPH and cribriform wax gland plates. Although in the present study, Poaceae feeding species in *Shivaphis* group were not included, other Poaceae feeding species were separated from *Shivaphis* clade. Therefore, to get a more reliable relationship of *Shivaphis*, a broadening taxon sampling of Poaceae feeders would be necessary. The occupation of Tiliaceae (Malvales) by *Eucallipterus*+*Tiliaphis* and following shift to juglandaceae (Fagales) could be subsequently leaded to third tribal radiation in Panaphidini. This results was not correspond to classical classification by Quednau (2003). According to him, *Chromaphis* and *Panaphis* are included into *Chromaphis* group, together with monotypic genus *Appendiseta* (Quednau, 2003). Nevertheless, close relation between *Tilia* feeding genera and Juglandaceae feeding genera partialy favored Quednau’s idea in some ways. Since Quednau’s system asserted that *Monellia*, the Nearctic genus on *Carya* (Juglandaceae), is comprised as *Eucallipterus* group.

Within Panaphidini, the shift to herbal angiosperms such as Poaceae and Fabaceae are of particular interest. Especially, the phylogenetic position of Saltusaphidinae was striking. This subfamily formed a basal clade of other herb feeding genera of Calaphidinae *s.s.* (Fig. 3.3, node P). This result revealed that their common ancester might shift directly from woody plant to herbaceous plant and such evolutionary event occurred only once (Fig. 3.3, node O). In contrast to this result, most herb feeding aphids seem to have obtained these host association through a host alternating life-cycle between both tree and herbs (Moran, 1992). It is an important result that overturns previous evolutionary hypothesis on acquisition of herb feeding in aphids.

Phylogenetic analyses shown that Myzocallidina is monophyletic with 3 subtribal subdivisions (Fig. 3.3, node T). One species, *Tuberculatus* (*Pacificallis*) *californicus* formed a basal node of Myzocallidina by separate from other *Pacificallis* species. Morphologically, this species has unique feature by having a pair of marginal setae in embryonic periods. Except for this species, myzocallidine species have only a single marginal seta in embryonic periods. Two species, *Tuberculatus* (*Orientuberculoides*) *capitatus* and *T* (*O*) *fangi*, formed the independent clade from other *Orientuberculoides* species (Fig. 3.3, node X). These two species can be separated by having 2 pairs of finger like tubercles on the pronotum. Myzocallidina has been considered as an early derived group than Panaphidina within the tribe Panphidini based on their host plant association with woody plants (Quednau, 1999; 2003). However, on the contrary to the previous assumption, this clade may have most recently been derived in Calaphidinae. Given this phylogenetic results, Fagales may be probably colonized at least 5 times in Calaphidinae.

The results of moleculr dating of Calaphidinae *s.l.* shown that Calaphidinae could arise in the late Cretaceous (Fig. 3.5). Based on Dholen & Moran (2000)’s study, divergence time of Calaphidinae has been regarded as late Cretaceous to Tertiary. For the Phyllaphidinae, Calaphidinae *s.s.* and the early diverging Panaphidina, host plants belonging to Fagales (Betulaceae and Fagaceae) were proposed as an ancestral host. Divrgence timing of Fagales has been assumed as upper Cretaceous at about 109.1 Ma (Magallon, 2015). Thus, divergence timing of Fagales and the early diverged Calaphidinae *s.l.* were overlapped.

Based on the ancestral host plant reconstruction and molecular dating anlaysis, the first plant order level host shift from Fagles to Rosales may occurred in the late Cretaceous (76.6 Ma). However, divergence time of Rosales group has been proposed earlier than those of Fagales (118.6 Ma) (Magallon, 2015). This result agrees with the host plant relationship evolution of aphids (Peccoud, 2009). In aphids, shifting to novel host plant is regarded as the main factor of the species divergence rather than a co-evolution with host plant (Peccoud, 2009). Such trend can be broadly observed in Calaphidinae *s.l.* Particulary, within the late diverged Panaphidina groups and Myzocallidina group, there was no clear patterns of divergence time overlapping of between aphids and host plants. For example, myzocallidine species have been considered as an older group in the Panaphidini based on their host plant association with Fagales plants. However, on the contrary to the previous assumption, this group may the youngest group in Calaphidinae *s.l.*

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Appendix I. Figure plates

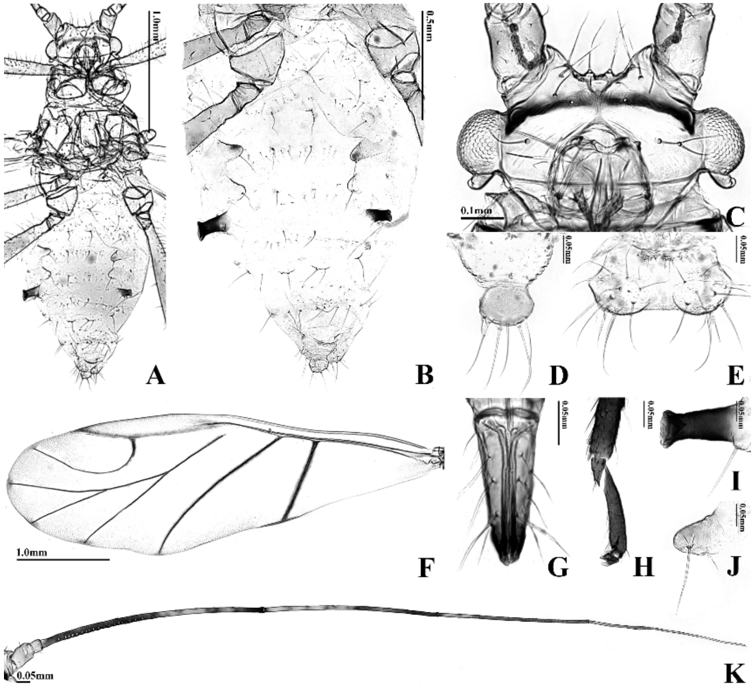


Fig. S1. Alate viviparous female of ***Betacallis alnicolens* Matsumura, 1919 오리나무알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

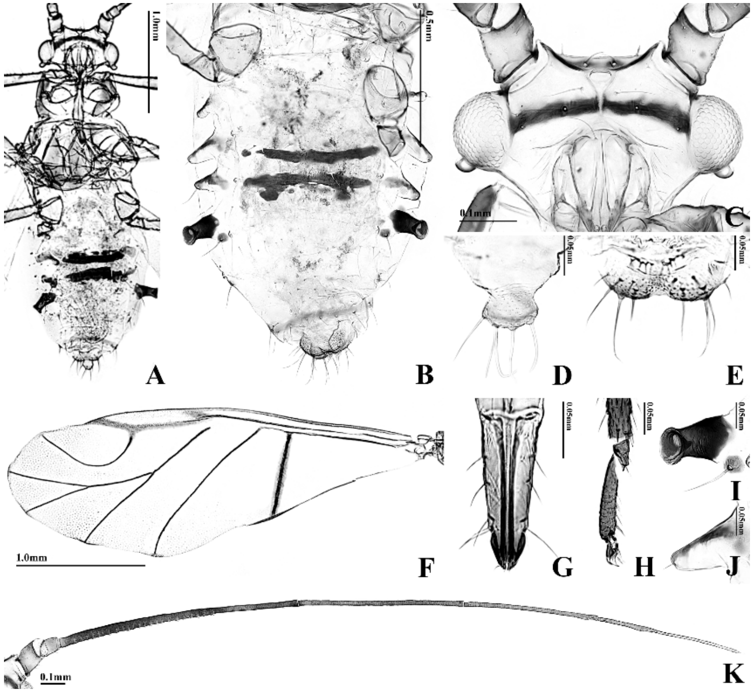


Fig. S2. Alate viviparous female of ***Betacallis trilineata* Lee, sp. nov. 세줄알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

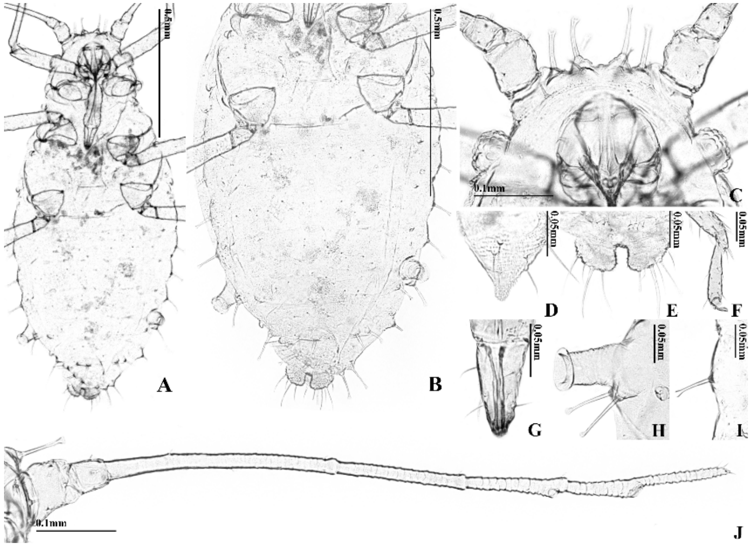


Fig. S3. Apterous viviparous female of ***Betulaphis quadrituberculats*** **(Kaltenbach, 1843) 자작알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, 2HT; G, URS; H, SIPH; I, 4MT; J, antenna).

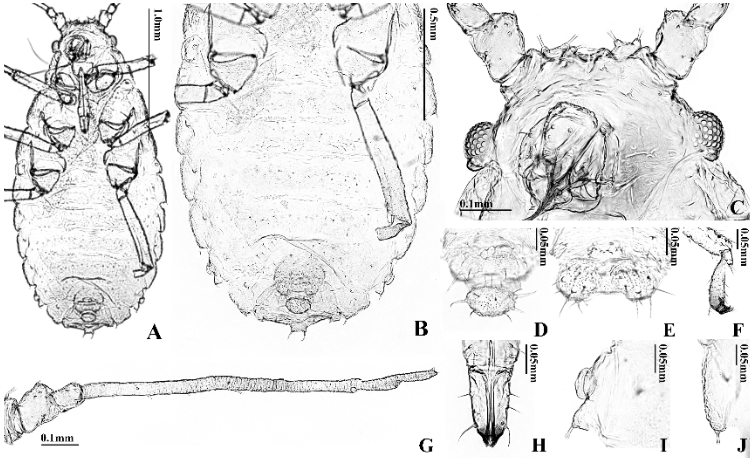


Fig. S4. Apterous viviparous female of ***Boernerina occidentalis*** **Hille Ris Lambers & Hottes, 1962 납작알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, 2HT; G, antenna; H, URS; I, SIPH; J, 4MT).

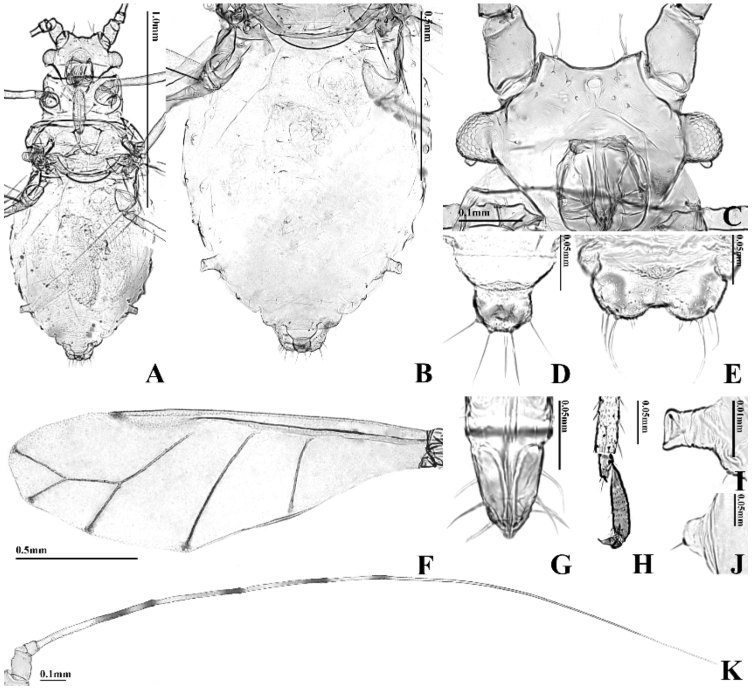


Fig. S5. Alate viviparous female of ***Calaphis magnoliae* Essig & Kuwana, 1918 목련알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

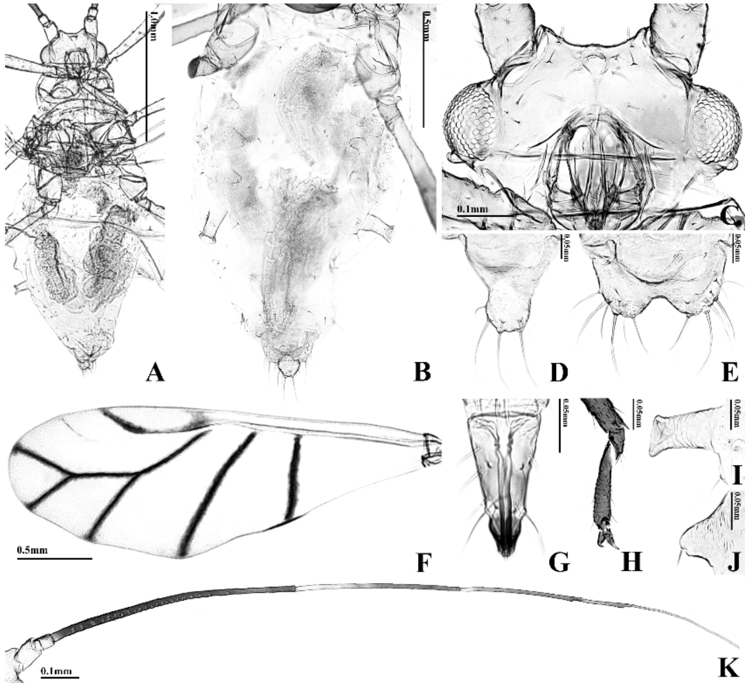


Fig. S6. Alate viviparous female of ***Calaphis similis* Quednau, 1979 검은맥알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

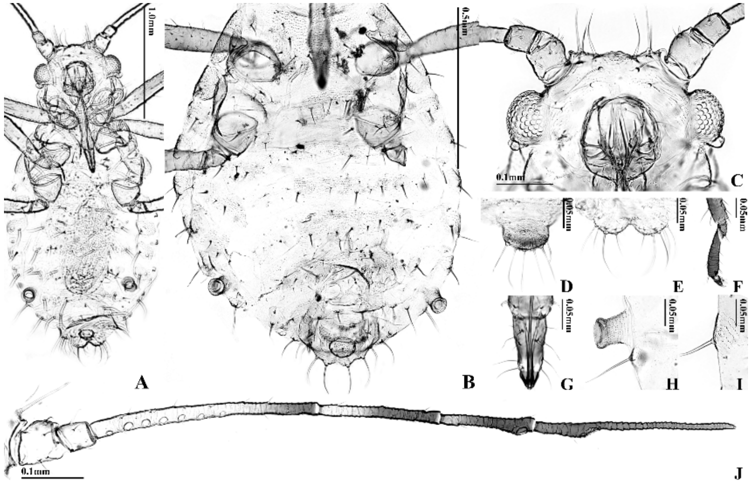


Fig. S7. Apterous viviparous female of ***Callipterinella calliptera*** **(Hartig, 1841) 작은알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, 2HT; G, URS; H, SIPH; I, 4MT; J, antenna).

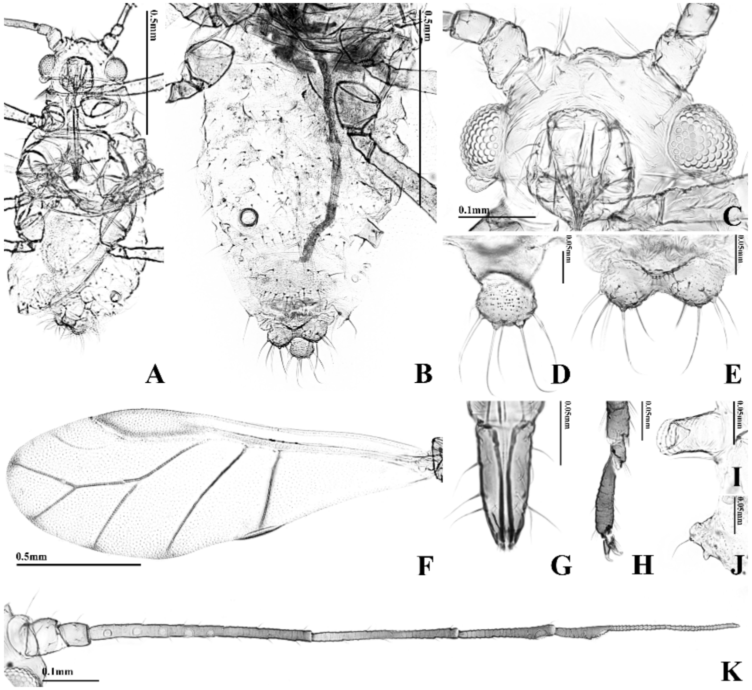


Fig. S7-2. Alate viviparous female of ***Callipterinella calliptera*** **(Hartig, 1841) 작은알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

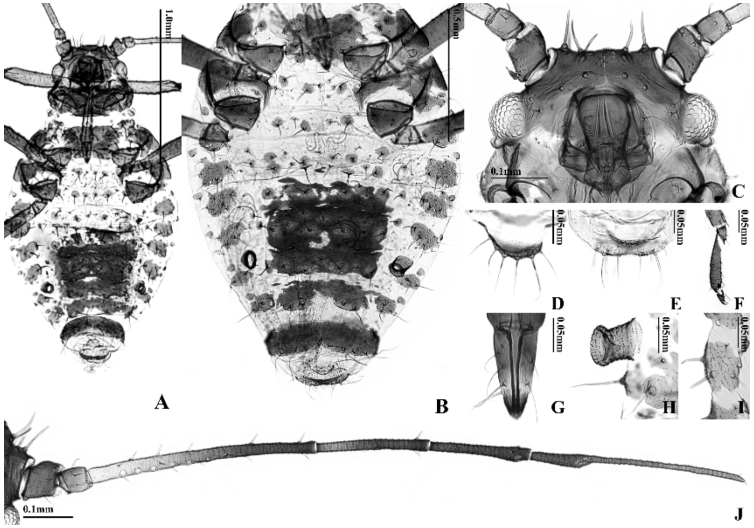


Fig. S8. Apterous viviparous female of ***Callipterinella tuberculata*** **(von Heyden, 1837) 작은줄알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, 2HT; G, URS; H, SIPH; I, 4MT; J, antenna).

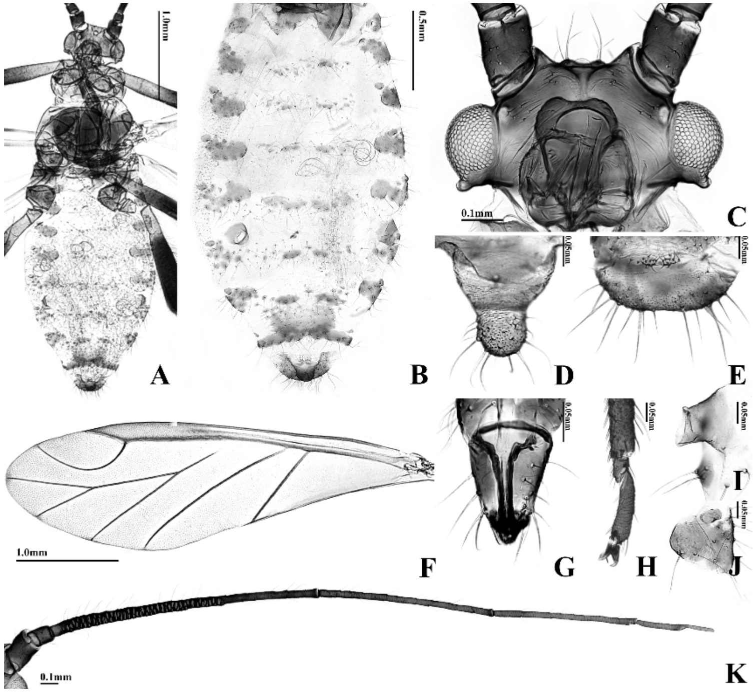


Fig. S9. Alate viviparous female of ***Clethrobius comes*** **(Walker, 1848) 갈색알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

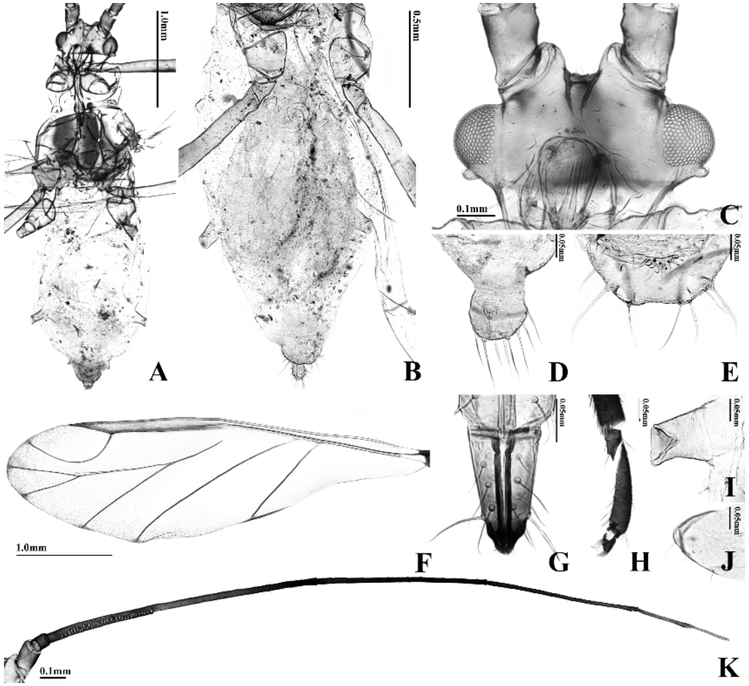


Fig. S10. Alate viviparous female of ***Euceraphis caerulescens*** **Pashtshenko, 1984 푸른가루알락진딧물속 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

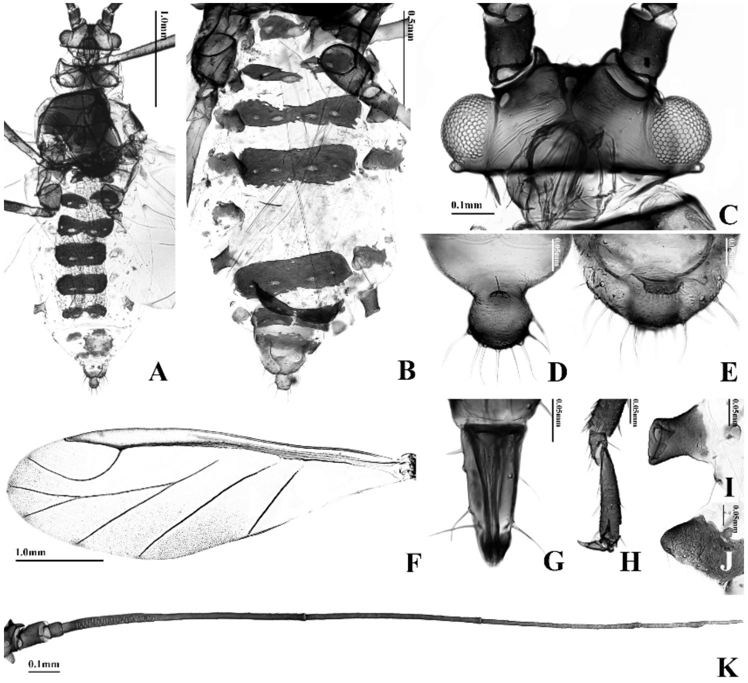


Fig. S11. Alate viviparous female of ***Euceraphis nigra*** **Lee, sp. nov. 검은가루알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

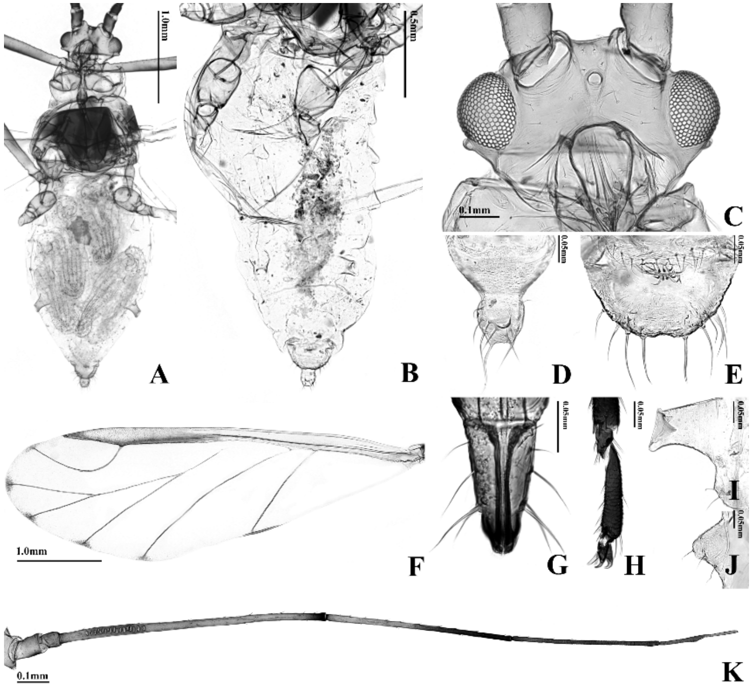


Fig. S12. Alate viviparous female of ***Euceraphis papyrifericola*** **Blackman, 2002 종이가루알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

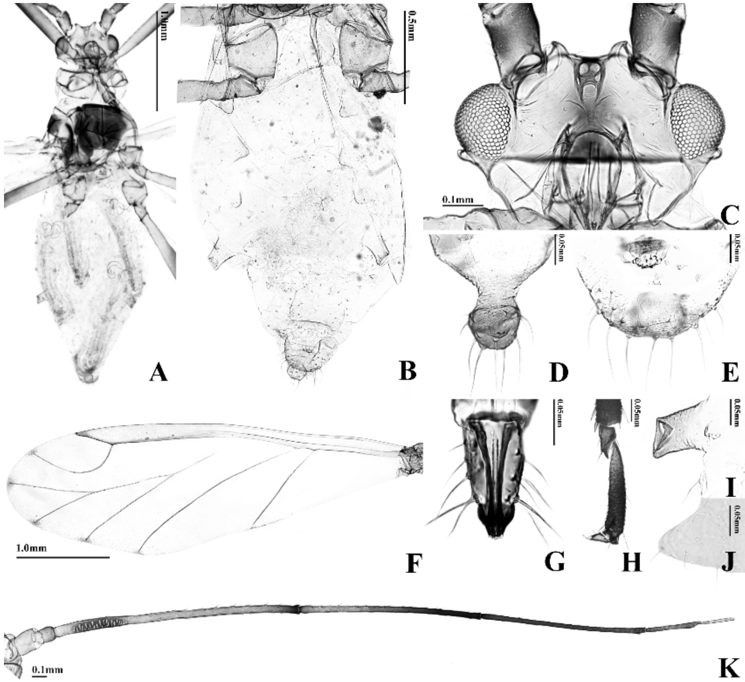


Fig. S13. Alate viviparous female of ***Euceraphis punctipennis*** **(Zetterstedt, 1840) 가루알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

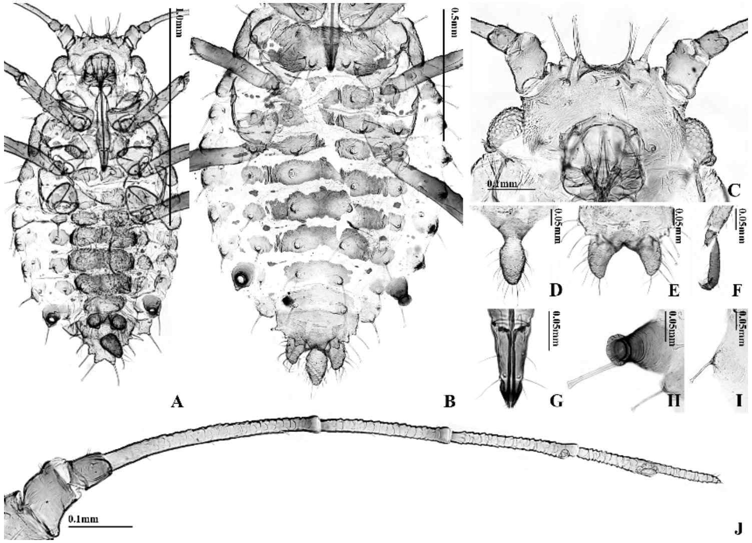


Fig. S14. Apterous viviparous female of ***Neobetulaphis pusila*** **Basu, 1964 못털자작알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, 2HT; G, URS; H, SIPH; I, 4MT; J, antenna).

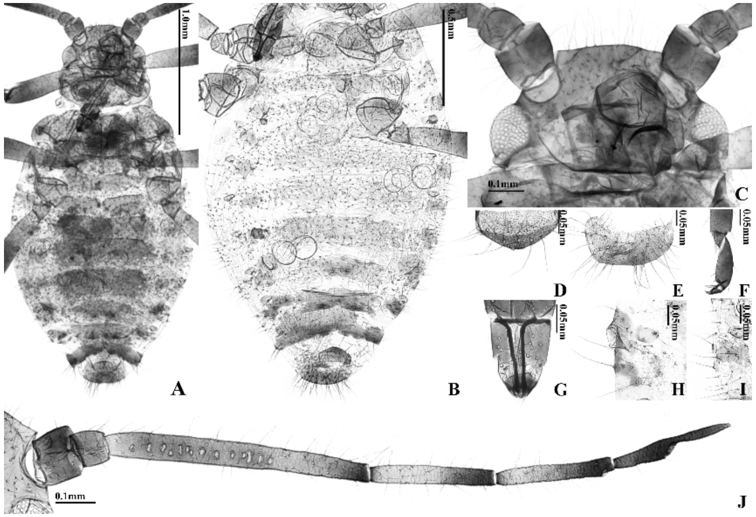


Fig. S15. Apterous viviparous female of ***Symydobius*** **(*Symydobius*) *minutus* Quednau & Shaposhnikov, 1988 작은털알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, 2HT; G, URS; H, SIPH; I, 4MT; J, antenna).

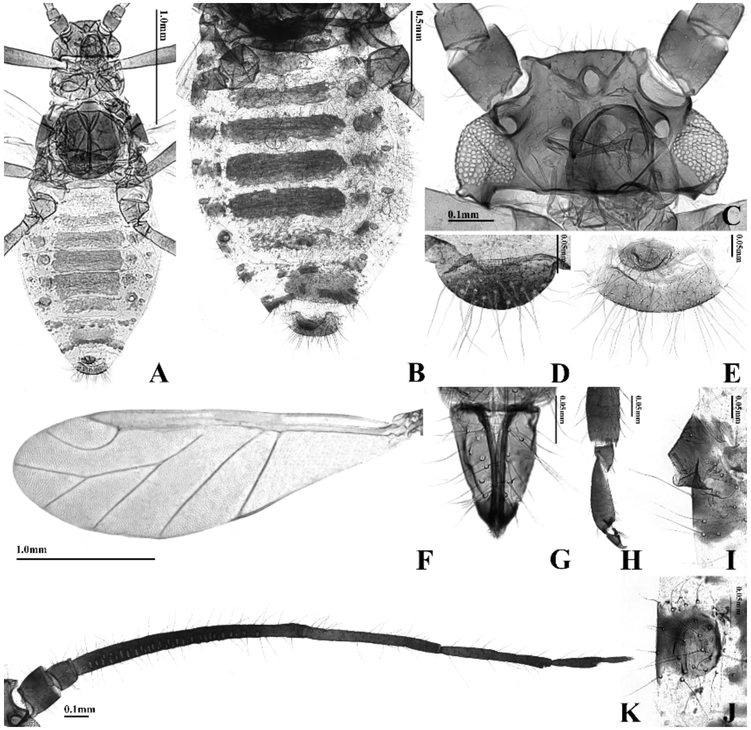


Fig. S15-2. Alate viviparous female of ***Symydobius* (*Symydobius*) *minutus* Quednau & Shaposhnikov, 1988 작은털알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

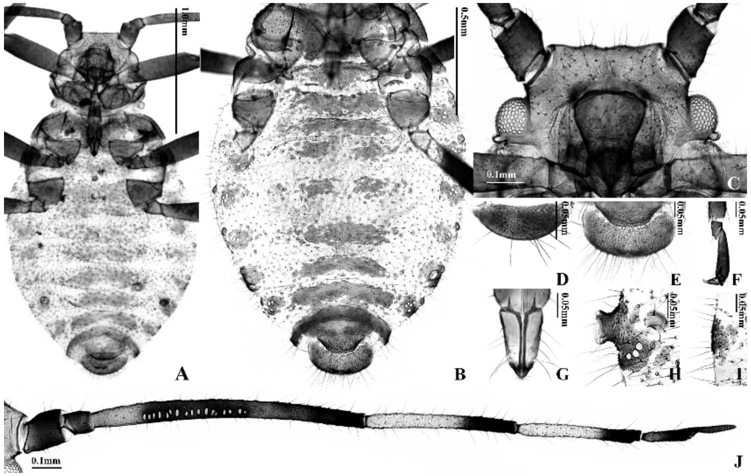


Fig. S16. Apterous viviparous female of ***Symydobius* (*Yezocallis*) *kabae* (Matsumura, 1917) 자작나무털진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, 2HT; G, URS; H, SIPH; I, 4MT; J, antenna).

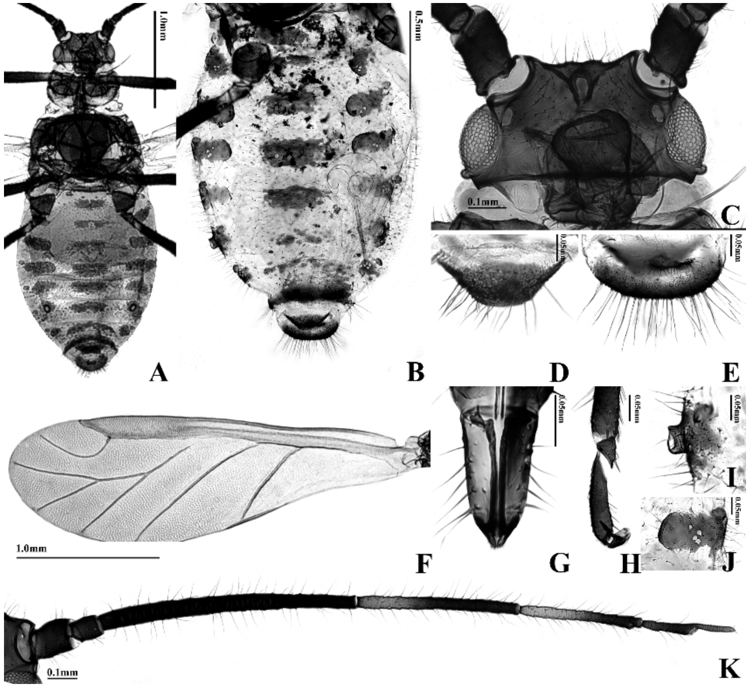


Fig. S16-2. Alate viviparous female of ***Symydobius* (*Yezocallis*) *kabae* (Matsumura, 1917) 자작나무털진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

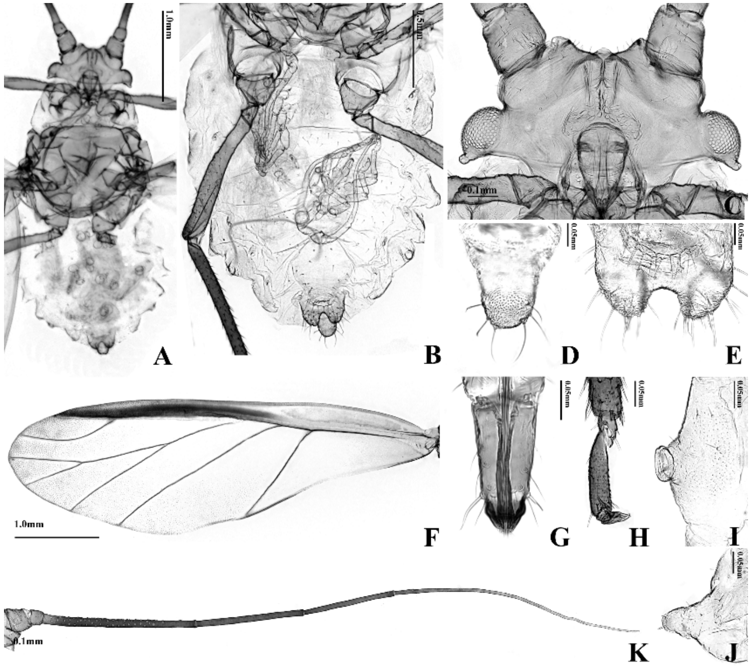


Fig. S17. Alate viviparous female of ***Monaphis antennata* (Kaltenbach, 1843) 더듬이긴알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

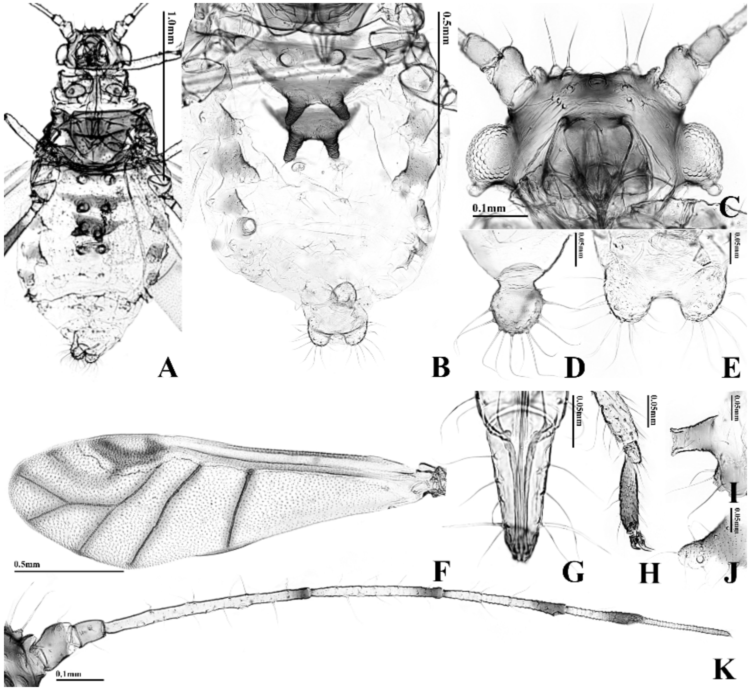


Fig. S18. Alate viviparous female of ***Tuberculatus* (*Acanthocallis*) *alienae* Lee, sp. nov. 갈참낙타진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

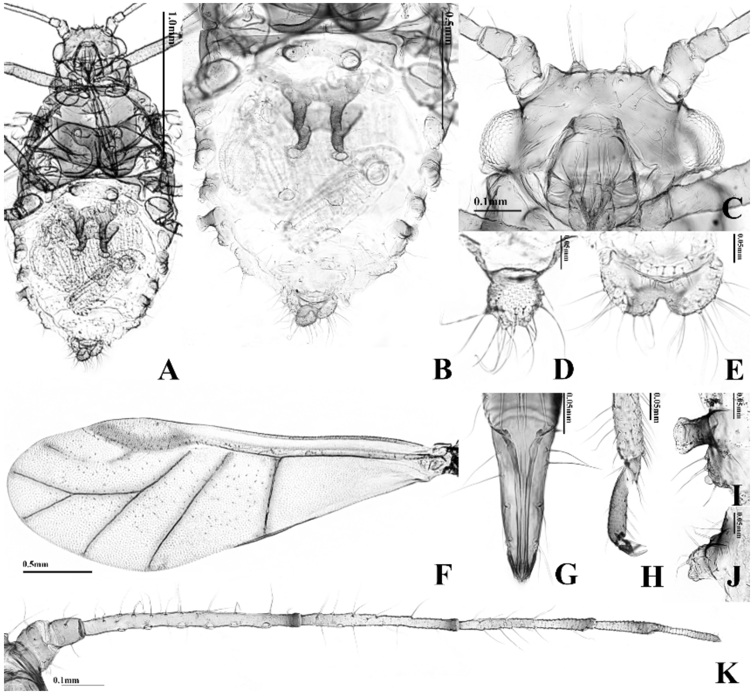


Fig. S19. Alate viviparous female of ***Tuberculatus* (*Acanthocallis*) *macrotuberculatus* (Essig & Kuwana, 1918) 큰혹낙타진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

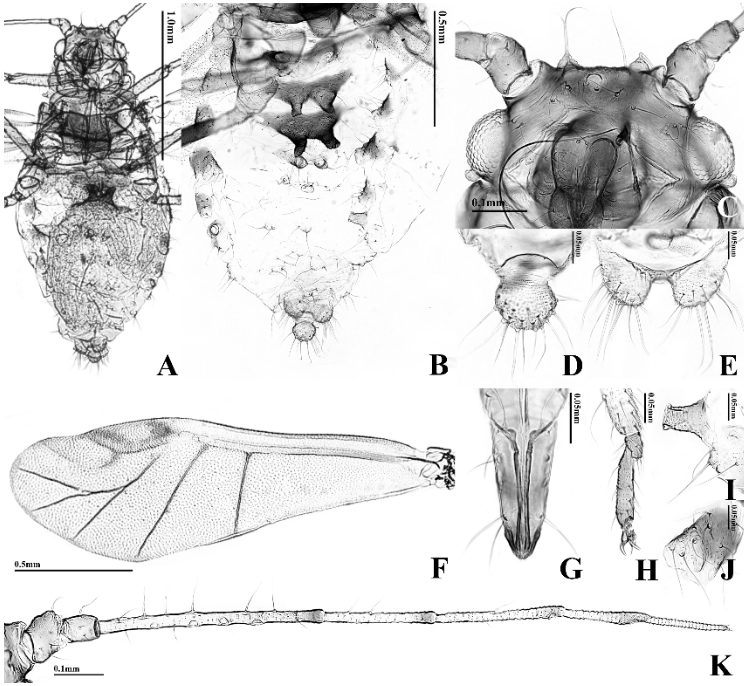


Fig. S20. Alate viviparous female of ***Tuberculatus* (*Acanthocallis*) *quercicola* Matsumura, 1917 낙타진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

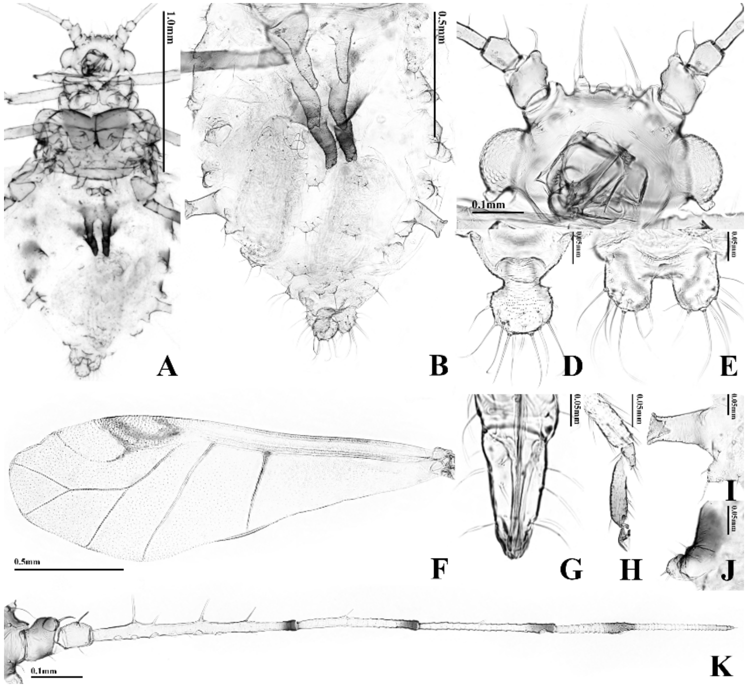


Fig. S21. Alate viviparous female of ***Tuberculatus* (*Acanthotuberculatus*) *acutissimae* Lee, sp. nov. 혹낙타진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

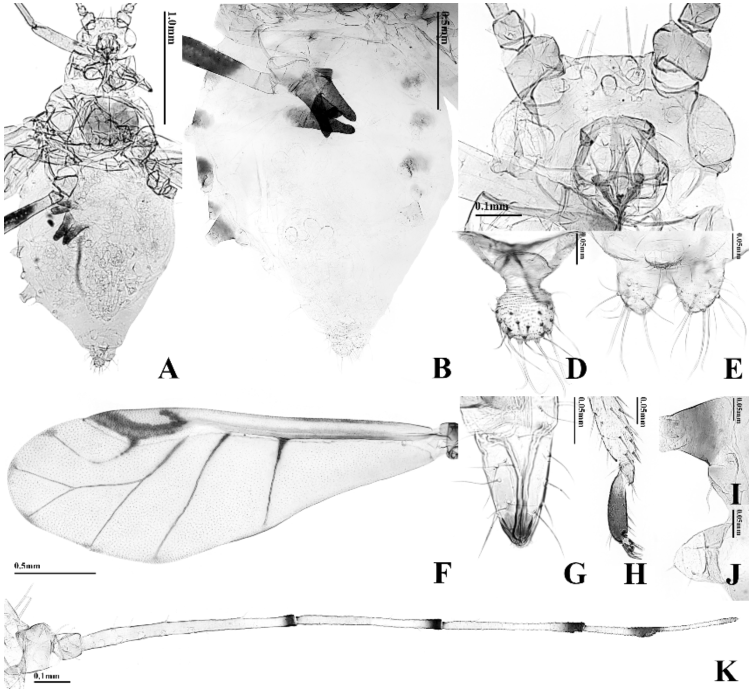


Fig. S22. Alate viviparous female of ***Tuberculatus* (*Acanthotuberculatus*) *indicus* Gosh, 1972 동양혹낙타진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

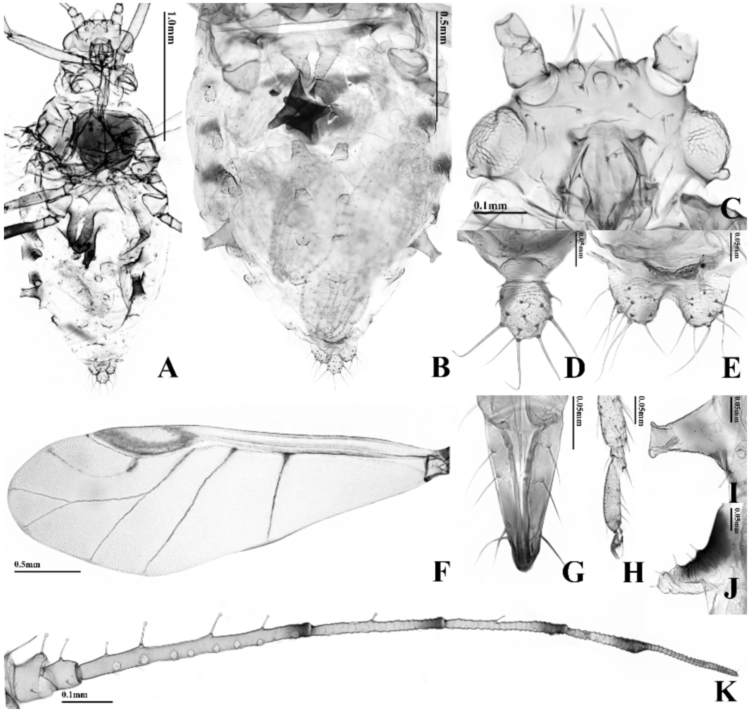


Fig. S23. Alate viviparous female of ***Tuberculatus* (*Acanthotuberculatus*) *japonicus* Higuchi, 1969 일본낙타진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

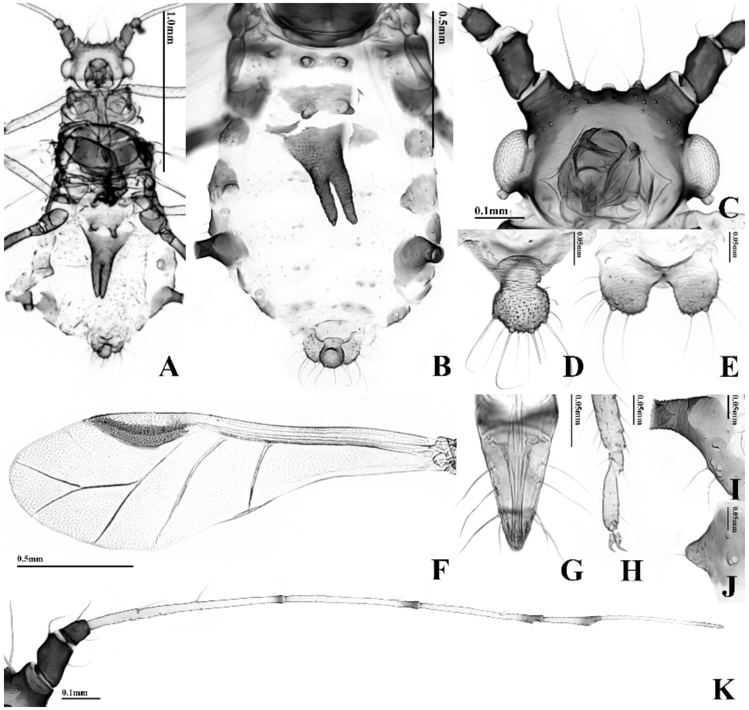


Fig. S24. Alate viviparous female of ***Tuberculatus* (*Arakawana*) *orientalis* Richards, 1968 stat. rev. 동양검은낙타진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

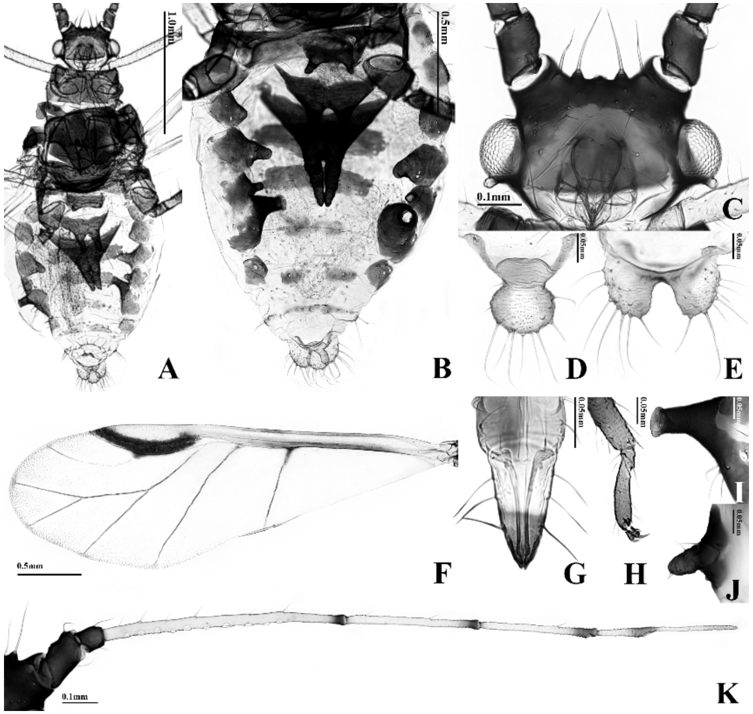


Fig. S25. Alate viviparous female of ***Tuberculatus* (*Arakawana*) *stigmatus* (Matsumura, 1917) 검은낙타진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

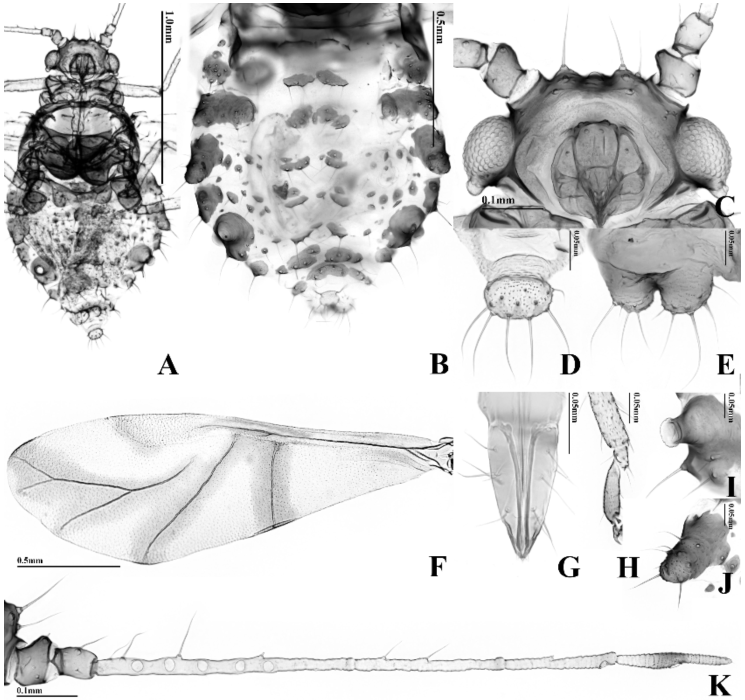


Fig. S26. Alate viviparous female of ***Tuberculatus*** **(*Nippocallis*)** ***hirta*** **Lee, sp. nov. 숨은밤나무낙타진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

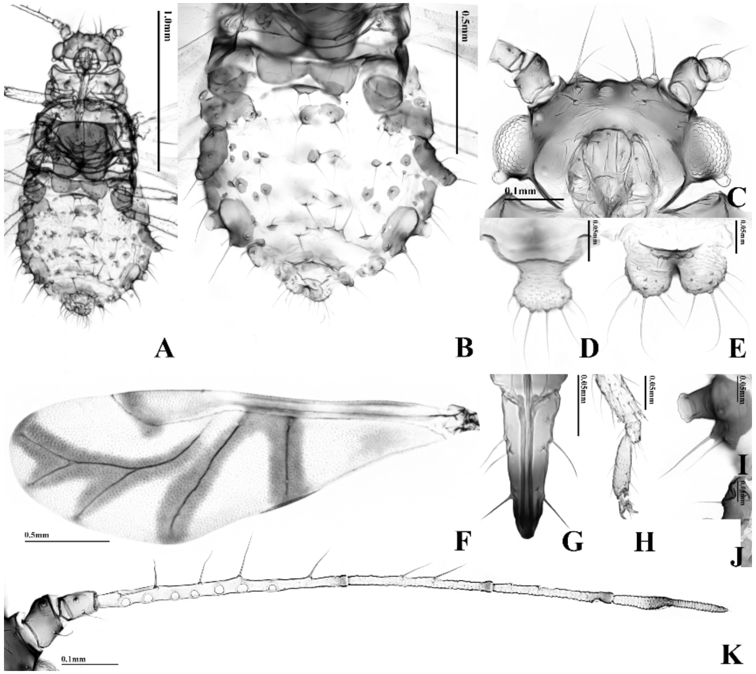


Fig. S27. Alate viviparous female of ***Tuberculatus*** **(*Nippocallis*)** ***kuricola*** **Matsumura, 1917 밤나무낙타진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

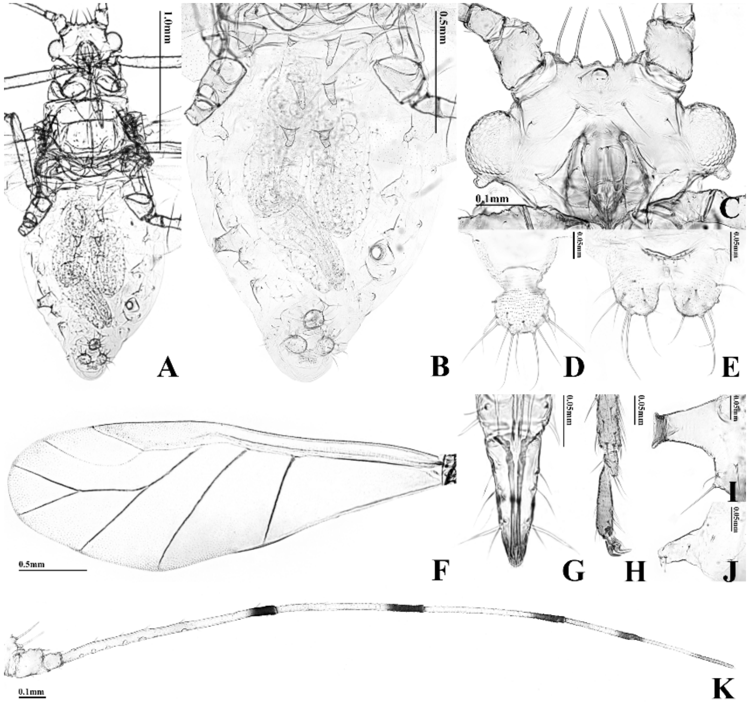


Fig. S28. Alate viviparous female of ***Tuberculatus* (*Orientuberculoides*) *alba* Lee, sp. nov. 흰동양낙타진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

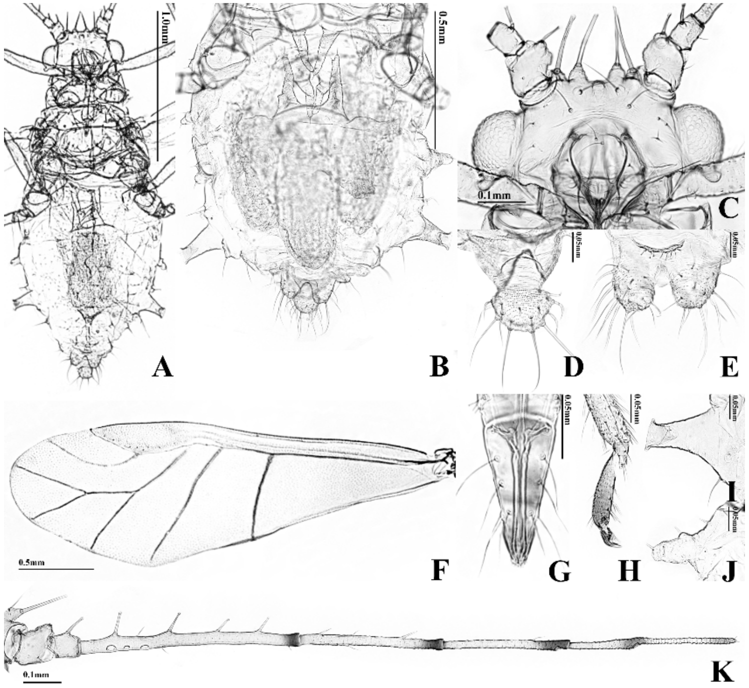


Fig. S29. Alate viviparous female of ***Tuberculatus* (*Orientuberculoides*) *capitatus* (Essig & Kuwana, 1918) 못털낙타진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

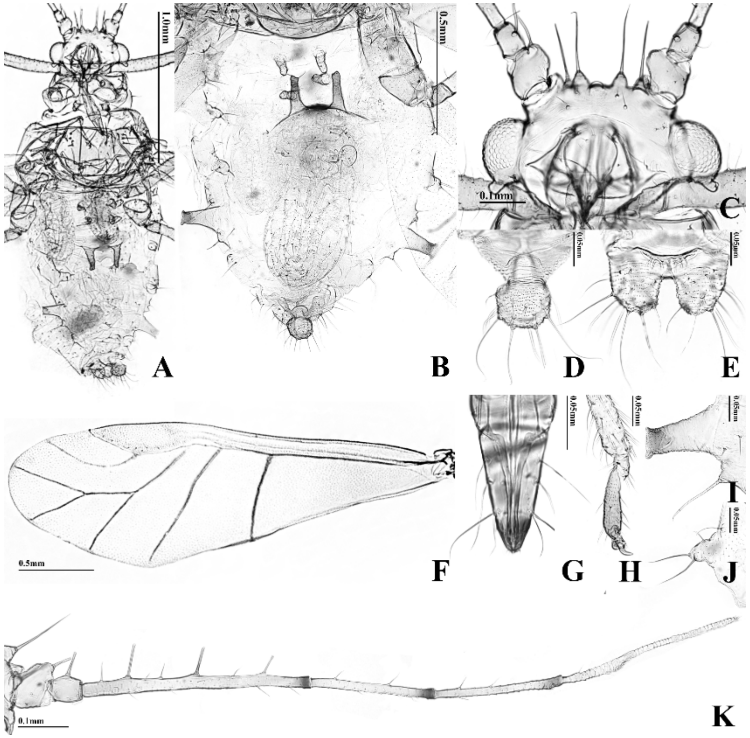


Fig. S30. Alate viviparous female of ***Tuberculatus* (*Orientuberculoides*) *fangi* (Tseng & Tao, 1938) 뾰족털낙타진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

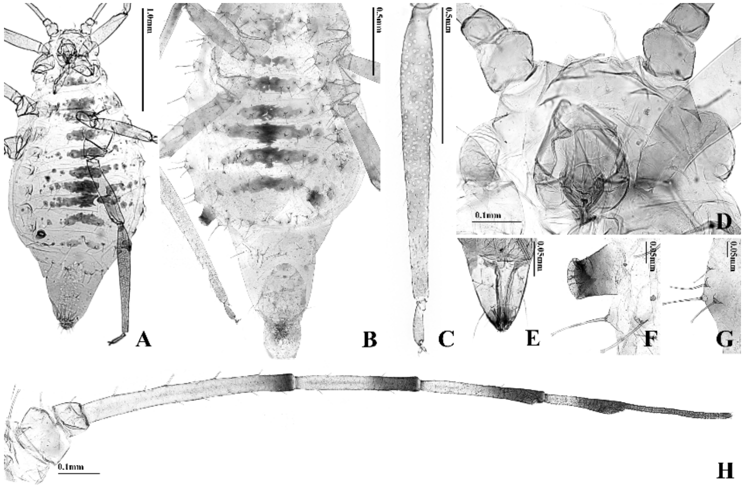


Fig. S31. Oviparous female of ***Tuberculatus* (*Orientuberculoides*) *fuscotuberculatus* Zhang, Zhang & Zhong, 1990 검은혹동양낙타진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

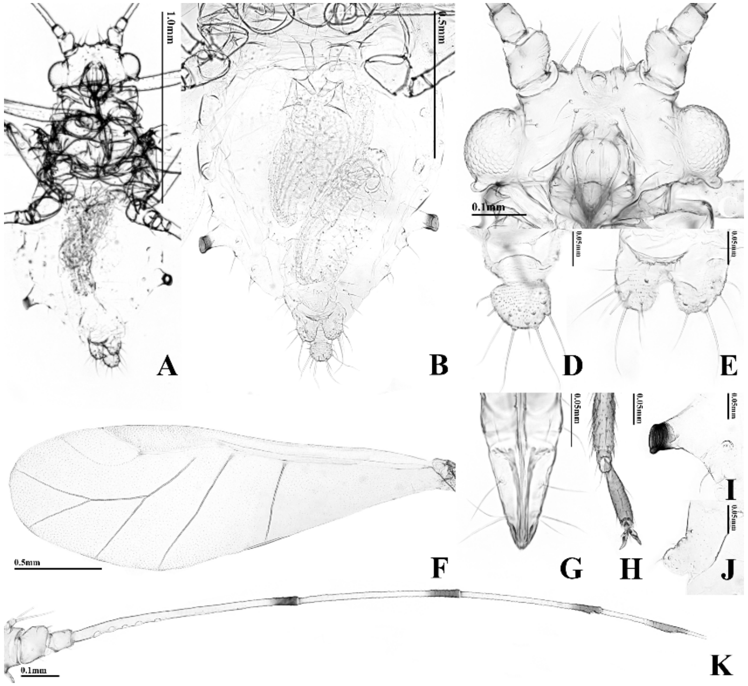


Fig. S32. Alate viviparous female of ***Tuberculatus*** **(*Orientuberculoides*)** ***higuchii*** **Hille Ris Lambers, 1974** **떡갈나무낙타진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

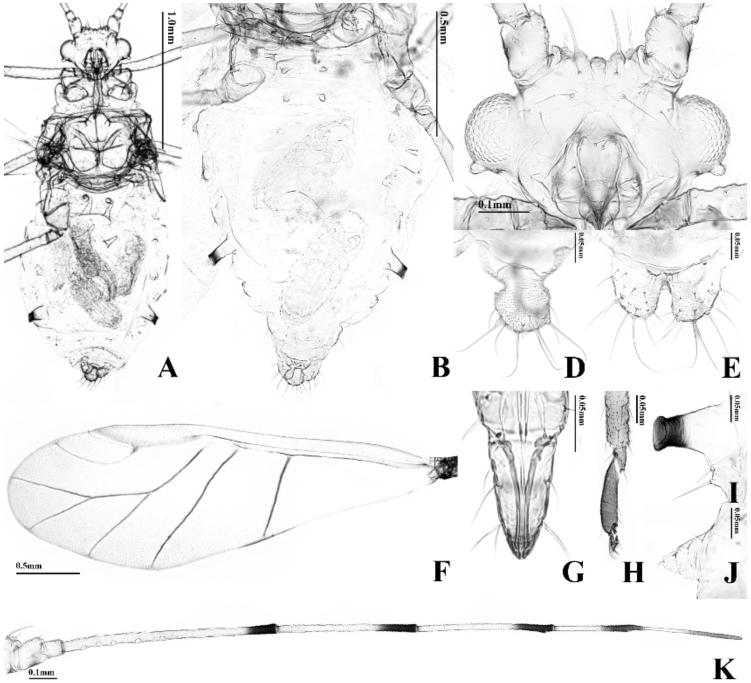


Fig. S33. Alate viviparous female of ***Tuberculatus*** **(*Orientuberculoides*)** ***lambersi*** **Lee, sp. nov.** **닮은떡갈나무낙타진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

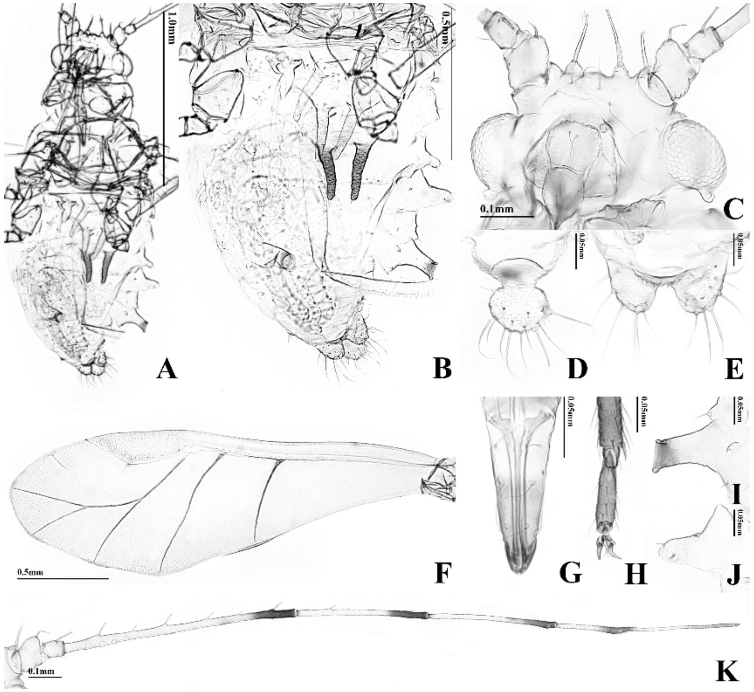


Fig. S34. Alate viviparous female of ***Tuberculatus* (*Orientuberculoides*) *paiki* Hille Ris Lambers, 1974** **백낙타진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

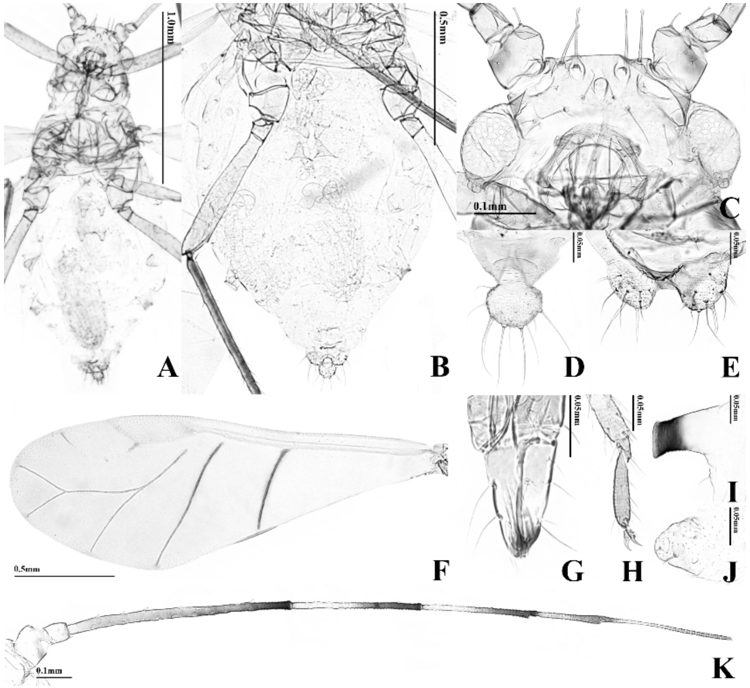


Fig. S35. Alate viviparous female of ***Tuberculatus* (*Orientuberculoides*) *paranacola* Hille Ris Lambers, 1974** **신갈낙타진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

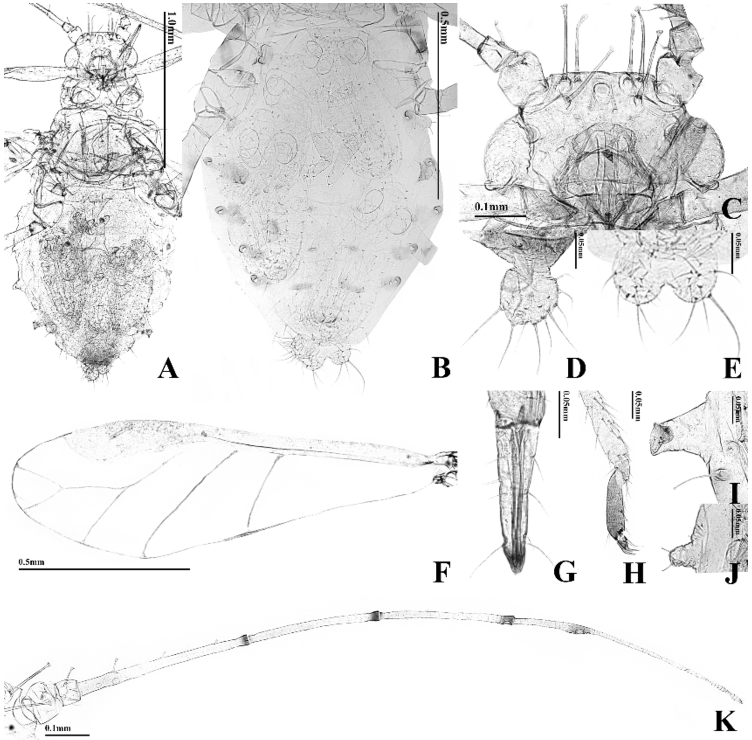


Fig. S36. Alate viviparous female of ***Tuberculatus*** **(*Orientuberculoides*) *querciformosanus* (Takahashi, 1921) 대만낙타진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

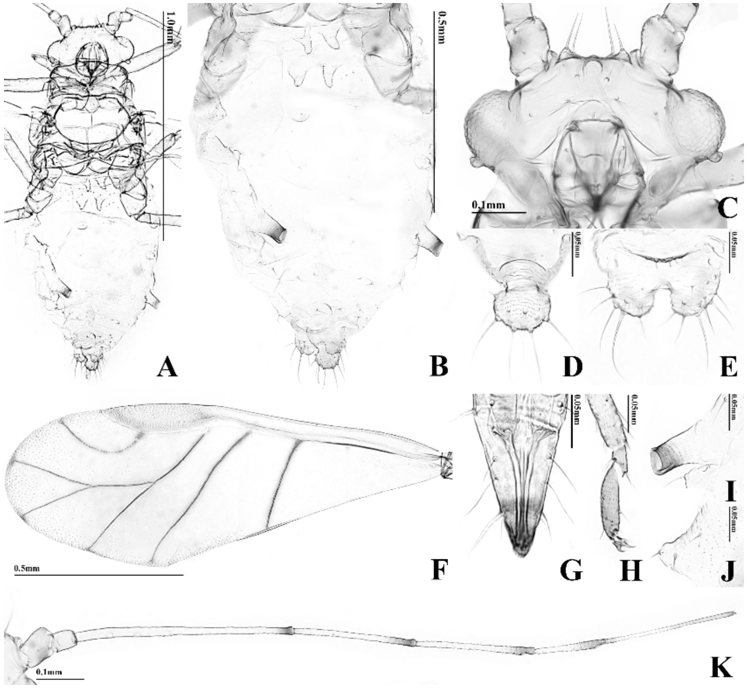


Fig. S37. Alate viviparous female of ***Tuberculatus*** **(*Orientuberculoides*) *richardsi* Lee, sp. nov. 닮은갈참나무낙타진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

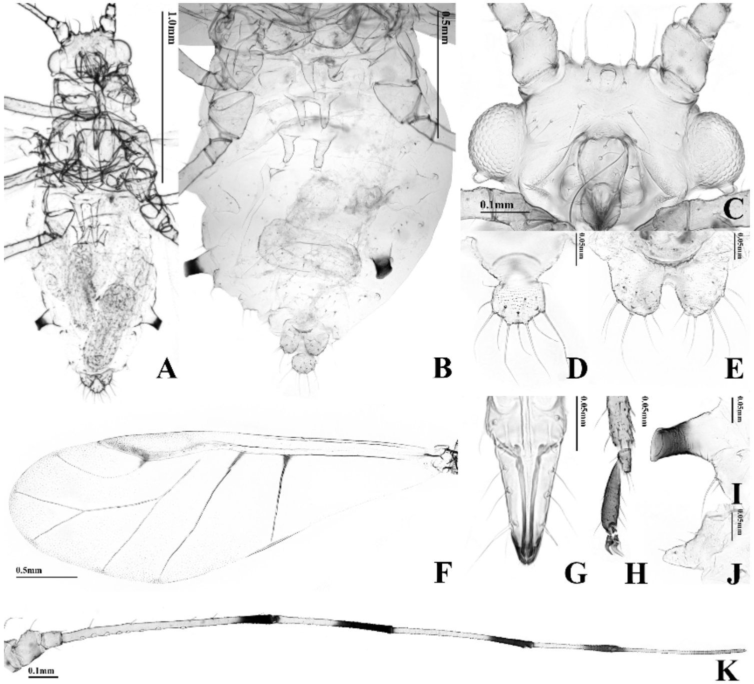


Fig. S38. Alate viviparous female of ***Tuberculatus* (*Orientuberculoides*) *silvae* Lee, sp. nov.** **참나무동양알락진딧물(신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

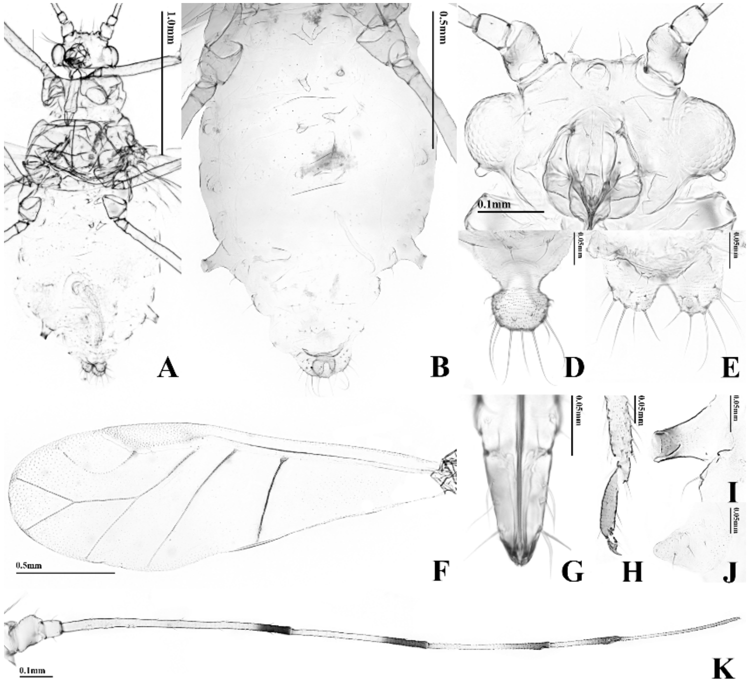


Fig. S39. Alate viviparous female of ***Tuberculatus* (*Orientuberculoides*) *yaoi* Lee, sp. nov.** **숨은동양알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

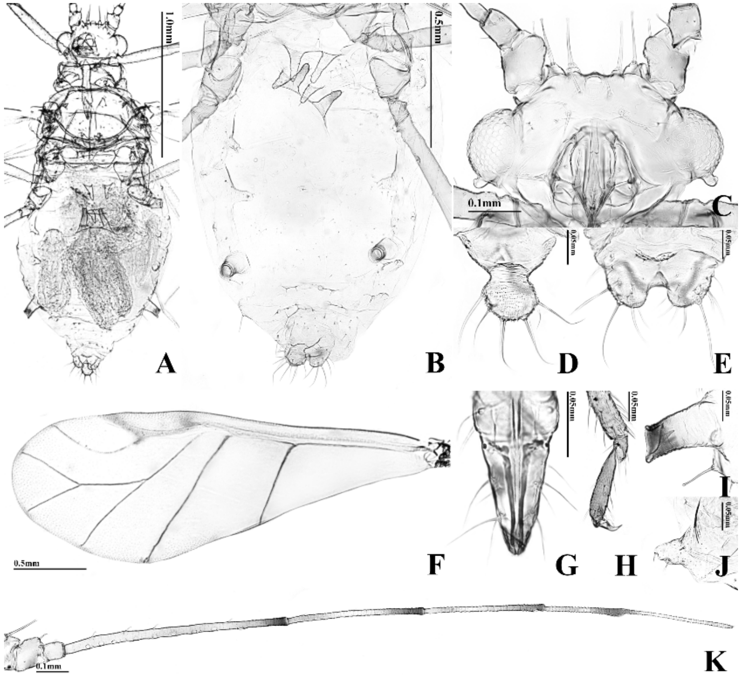


Fig. S40. Alate viviparous female of ***Tuberculatus* (*Orientuberculoides*) *yokoyamai* (Takahashi, 1923) 남방낙타진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

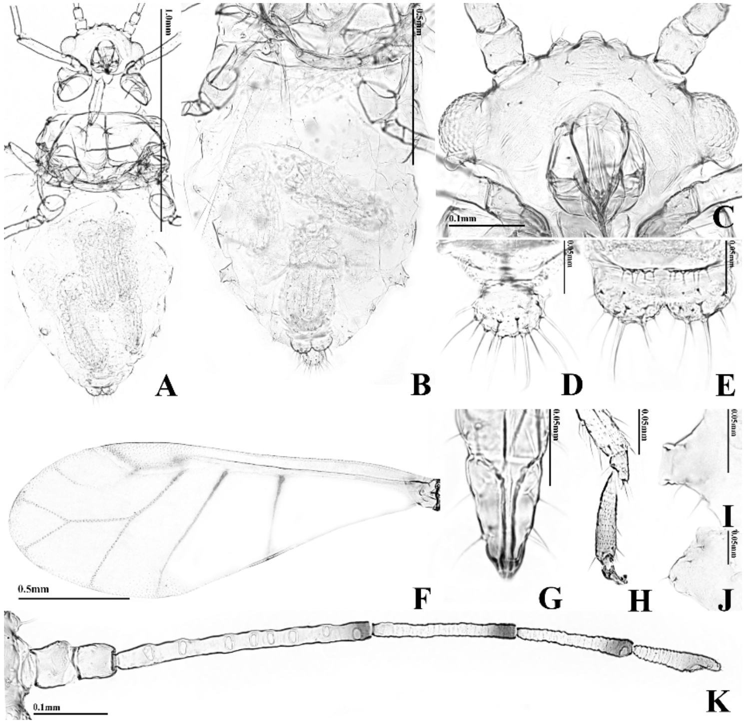


Fig. S41. Alate viviparous female of ***Chromaphis juglandicola* (Kaltenbach, 1824) 호두알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

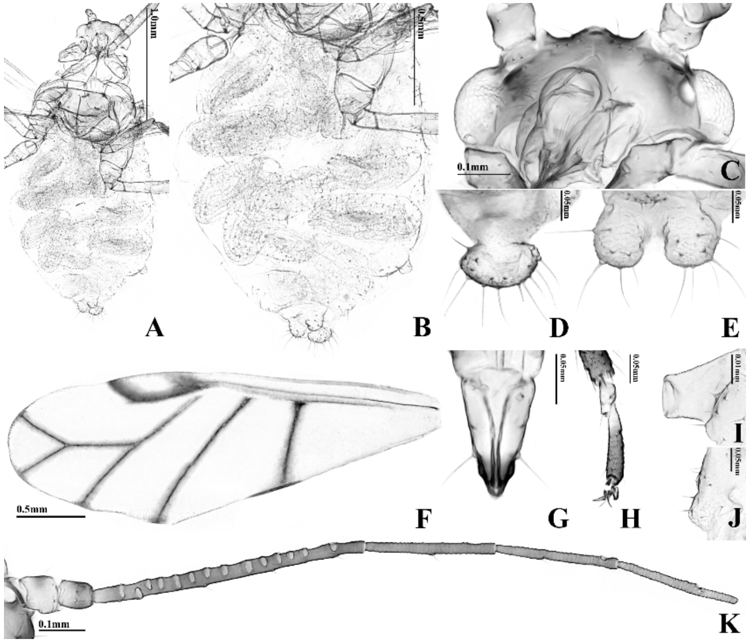


Fig. S42. Alate viviparous female of ***Chromocallis nirecola* (Shinji, 1933) 초록알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

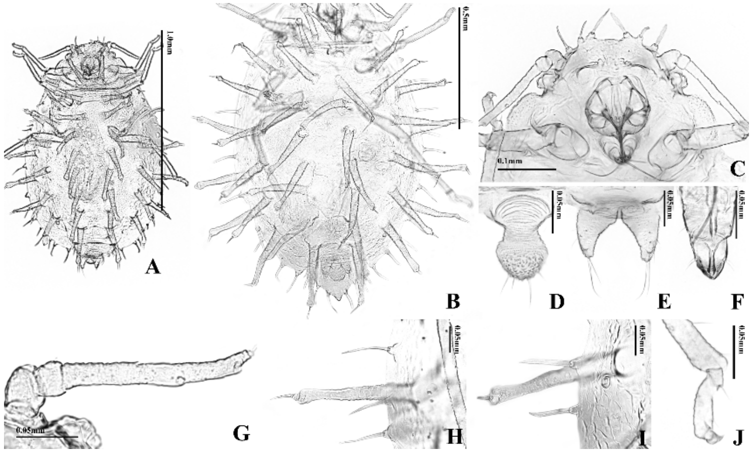


Fig. S43. Apterous viviparous female of ***Dasyaphis rhusae* (Shinji, 1922) 납작가시진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, URS; G, antenna; H, 4th margin; I, SIPH; J, 2HT).

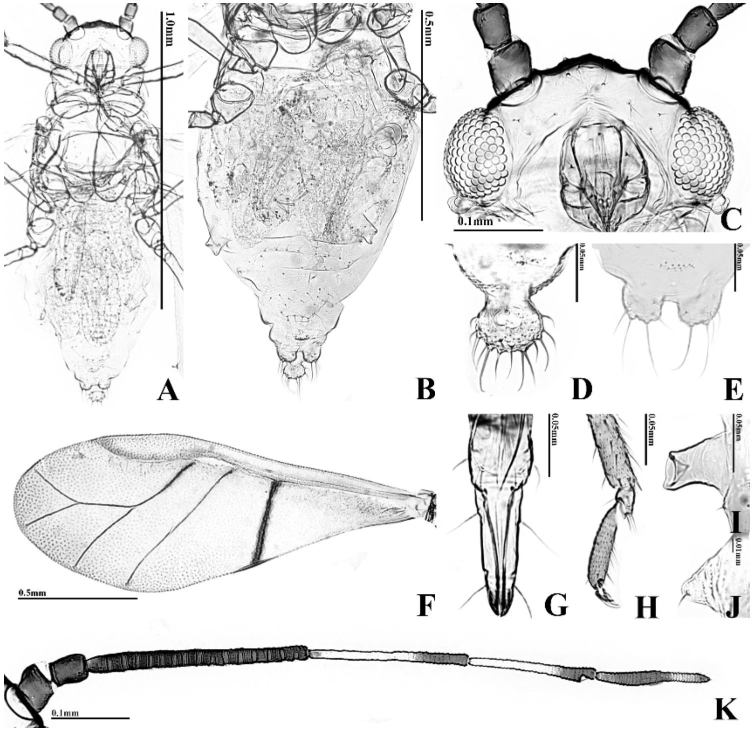


Fig. S44. Alate viviparous female of ***Mesocallis* (*Mesocallis*) *carpinicola* Lee, sp. nov. 서나무검은줄알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

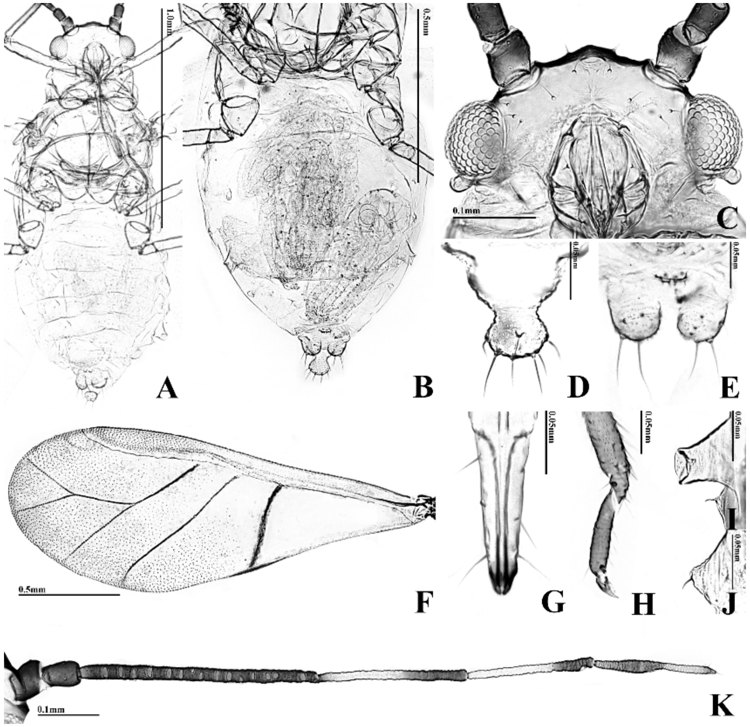


Fig. S45. Alate viviparous female of ***Mesocallis* (*Mesocallis*) *pteleae* Matsumura, 1919 검은줄알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

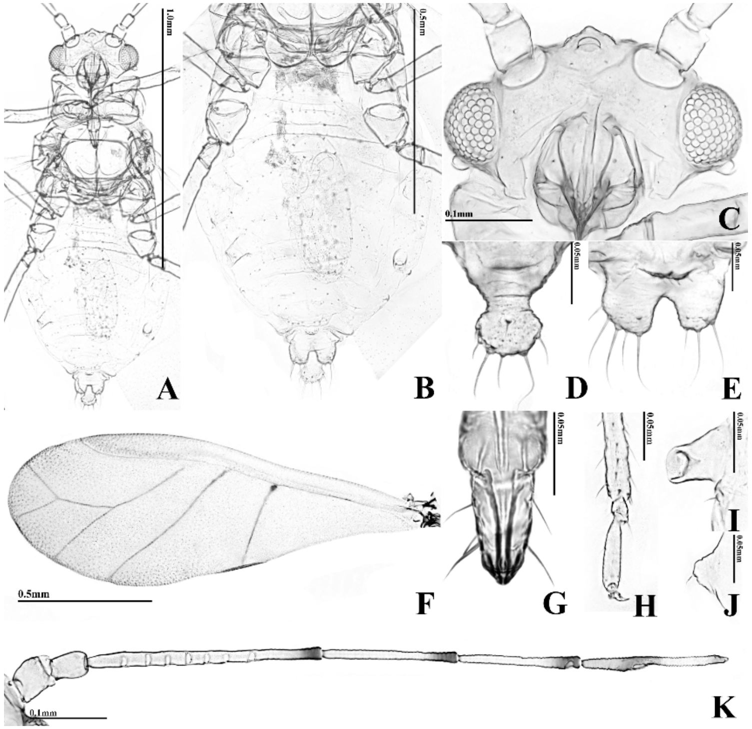


Fig. S46. Alate viviparous female of ***Mesocallis* (*Mesocallis*) *sawashibae* (Matsumura, 1917) 서나무노랑알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

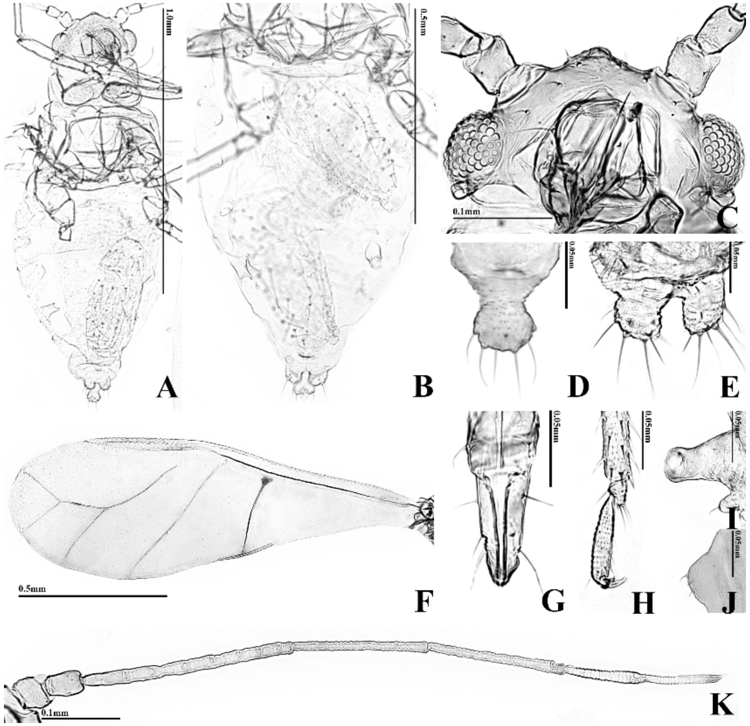


Fig. S47. Alate viviparous female of ***Mesocallis* (*Paratinocallis*) *corylicola* (Higuchi, 1972) 흰개암알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

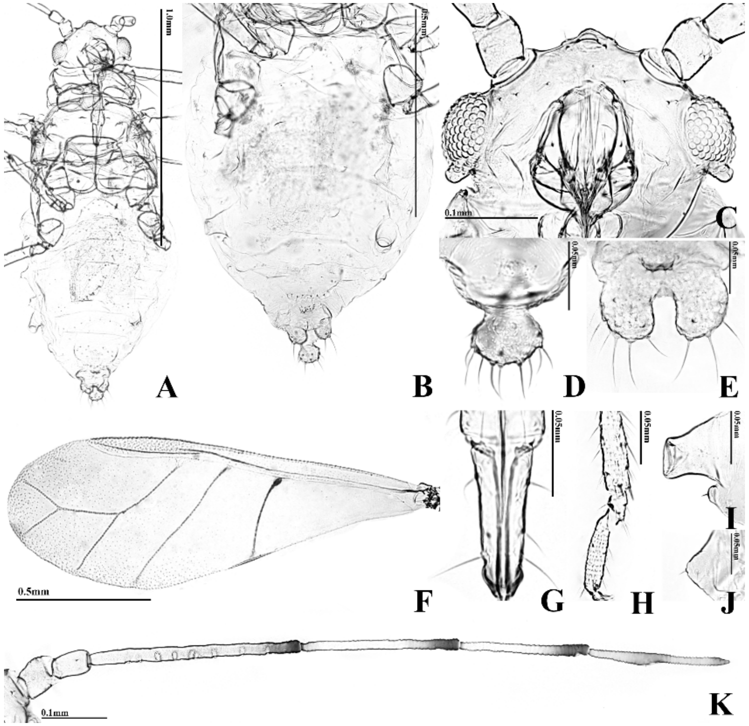


Fig. S48. Alate viviparous female of ***Mesocallis* (*Paratinocallis*) *occultus* Lee, sp. nov. 우리흰개암알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

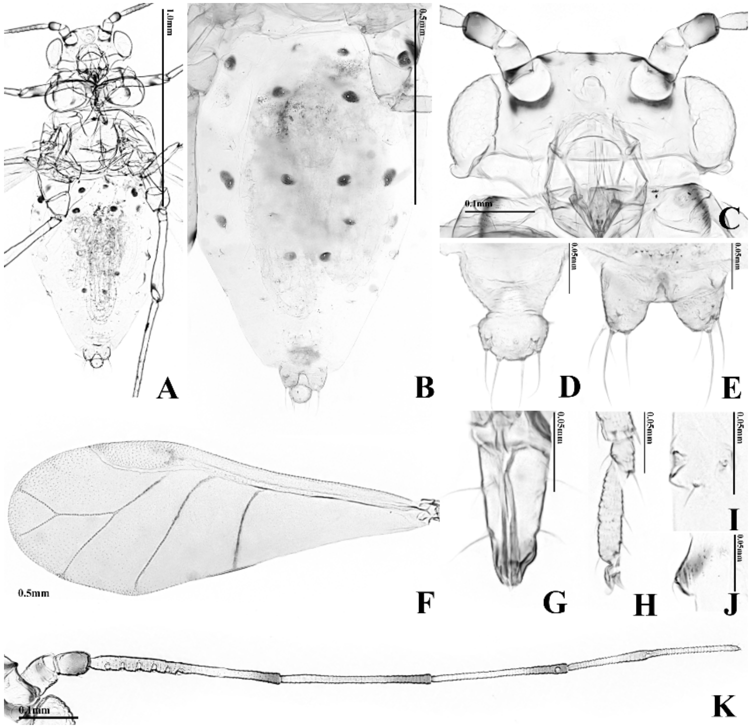


Fig. S49. Alate viviparous female of ***Monelliopsis caryae* (Monell, 1879) 무늬호두알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

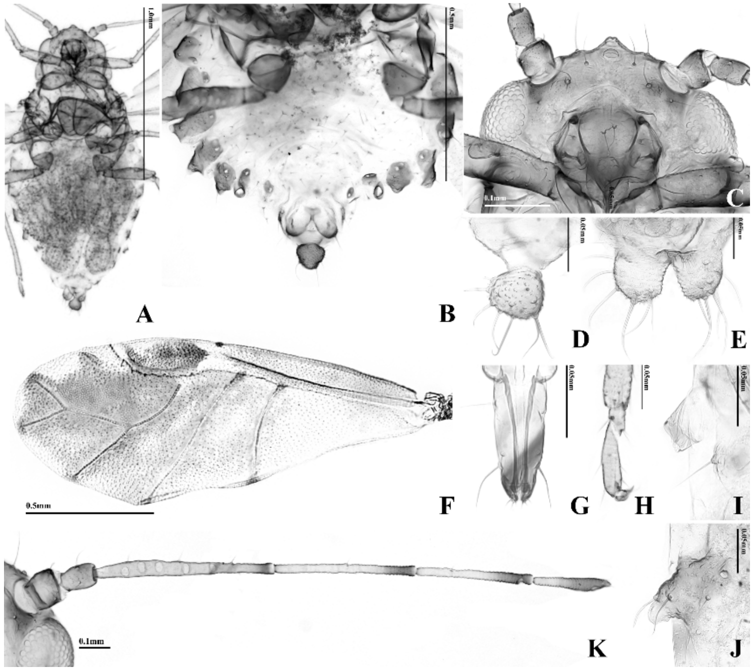


Fig. S50. Alate viviparous female of ***Neochromaphis carpinicola* (Takahashi, 1921) 날개알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

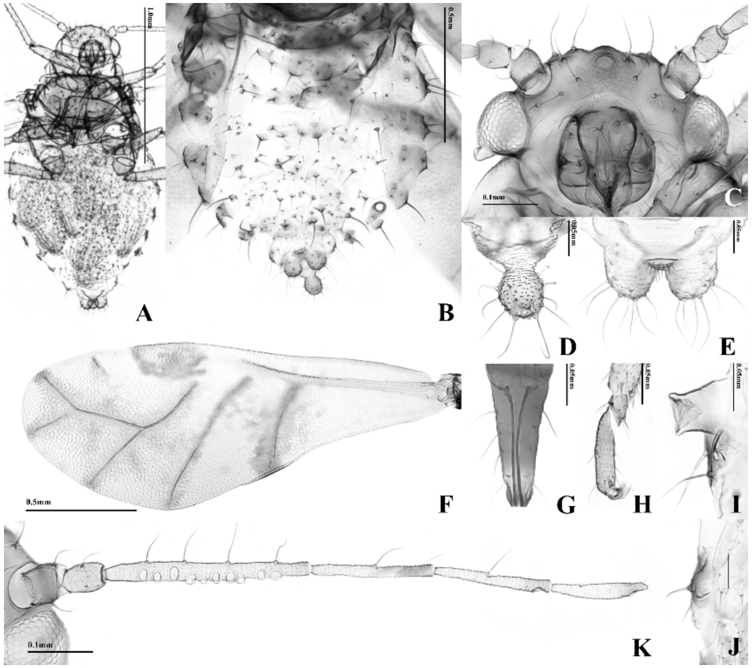


Fig. S51. Alate viviparous female of ***Neochromaphis coryli* (Takahashi, 1961) 개암나무알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

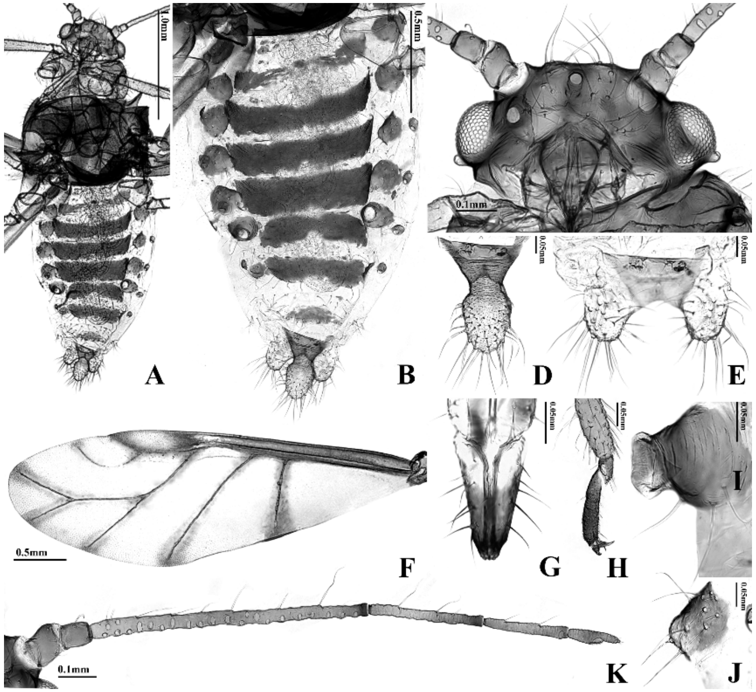


Fig. S52. Alate viviparous female of ***Panaphis juglandis* (Goeze, 1778) 호두털알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

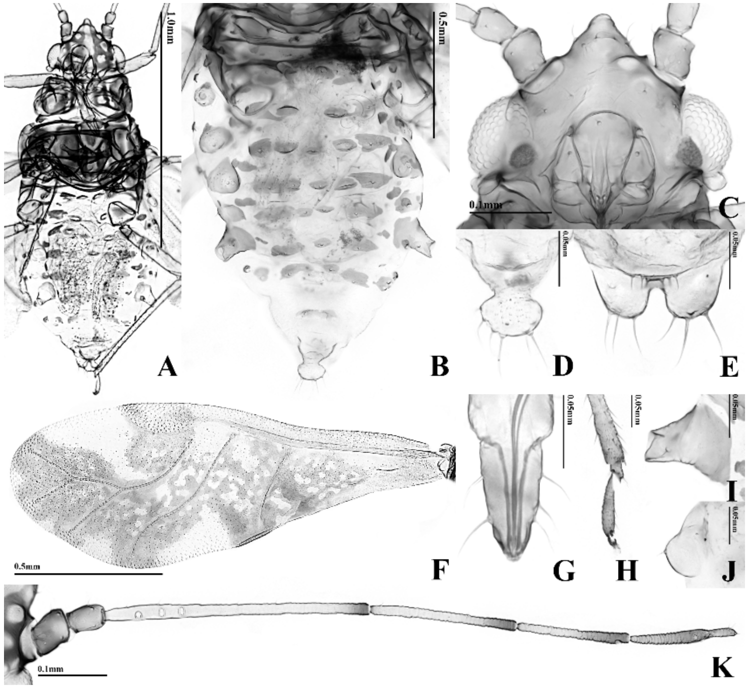


Fig. S53. Alate viviparous female of ***Pseudochromaphis coreana* (Paik, 1965) 시나무알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

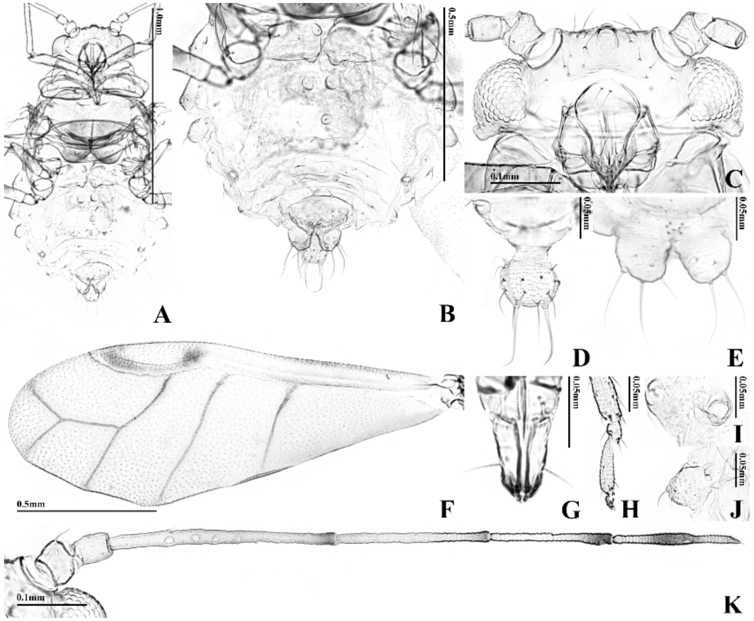


Fig. S54. Alate viviparous female of ***Pterocallis* (*Pterocallis*) *hetrophylla* Quednau, 1979 난퇴잎개암나무알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

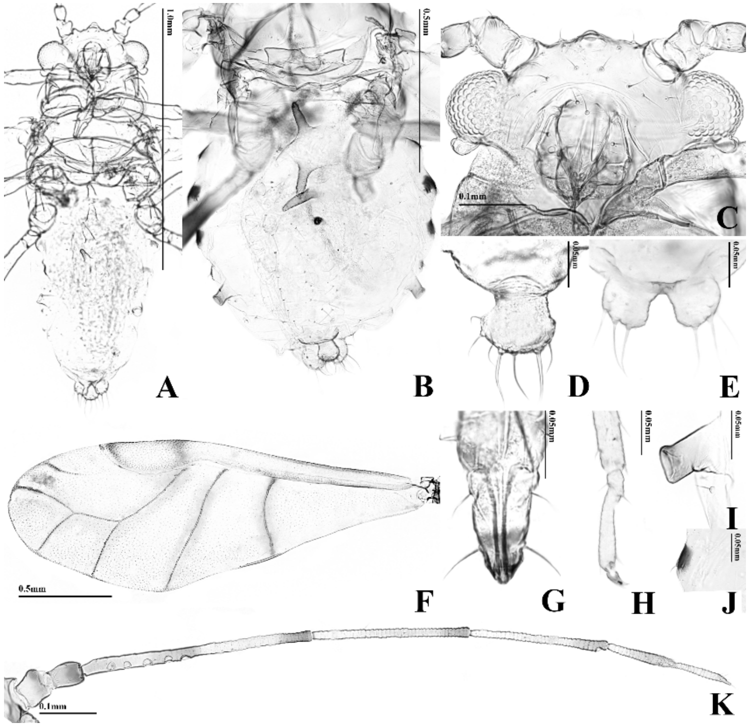


Fig. S55. Alate viviparous female of ***Pterocallis* (*Recticallis*) *alnijaponicae* Matsumura, 1919 일본외줄낙타진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

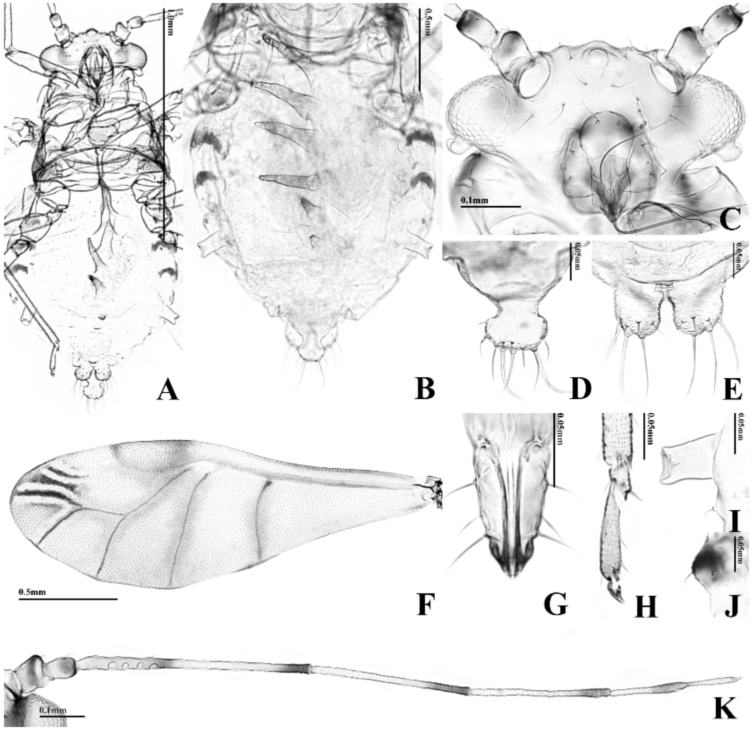


Fig. S56. Alate viviparous female of ***Pterocallis* (*Recticallis*) *alnijaponicae* Matsumura, 1919 일본외줄낙타진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

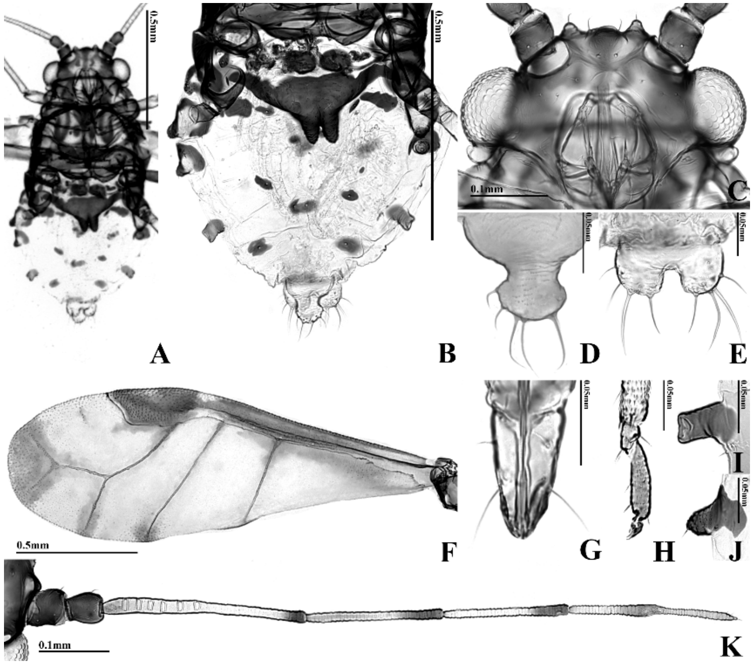


Fig. S57. Alate viviparous female of ***Sarucallis kahawaluokalani* (Kirkaldy, 1907) 배롱나무알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

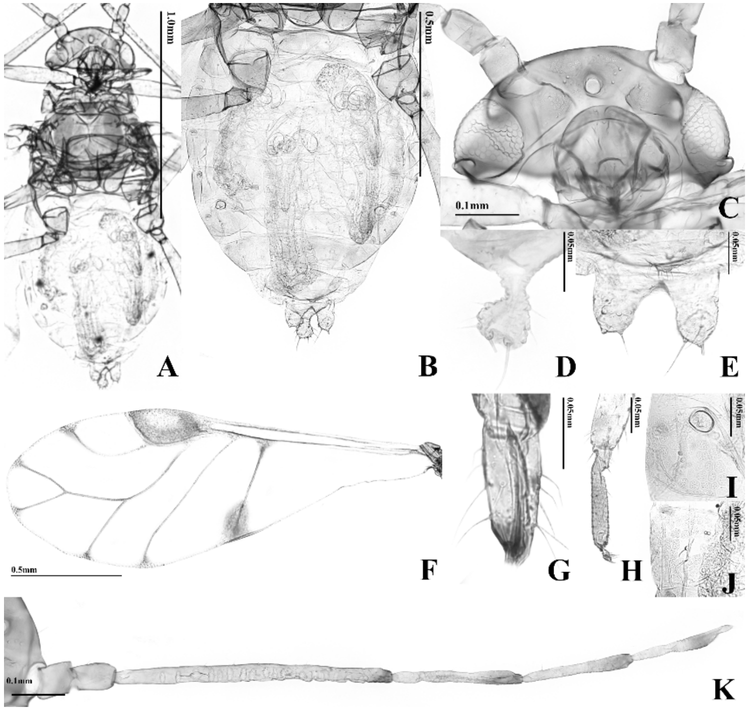


Fig. S58. Alate viviparous female of ***Shivaphis*** (***Shivaphis***) ***catalpinari*** **Quednau & Remaudière, 1985 풍게나무알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

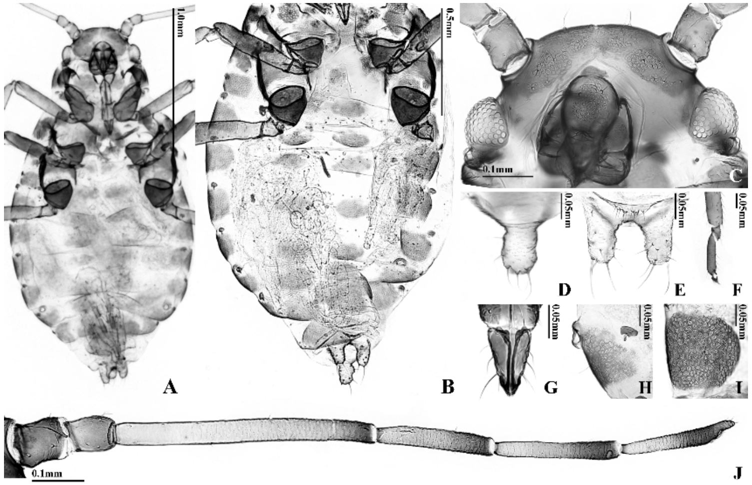


Fig. S59. Alate viviparous female of ***Shivaphis*** (***Shivaphis***) ***celti*** **Das, 1918 팽나무알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, 2HT; G, URS; H, SIPH; I, 4th margin; J, antenna).

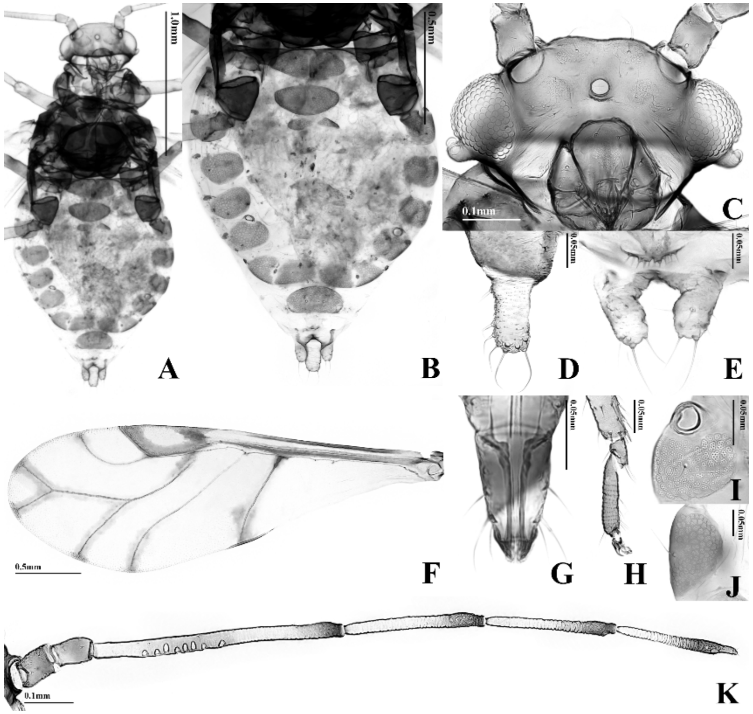


Fig. S59-2. Alate viviparous female of ***Shivaphis* (*Shivaphis*) *celti* Das, 1918 팽나무알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

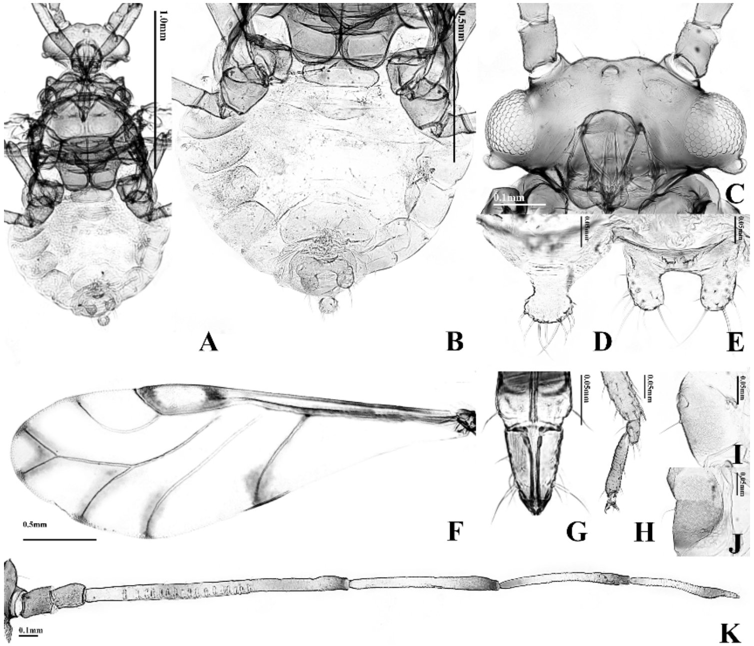


Fig. S60. Alate viviparous female of ***Shivaphis* (*Shivaphis*) *sinensis* Lee, sp. nov. 섬팽나무알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

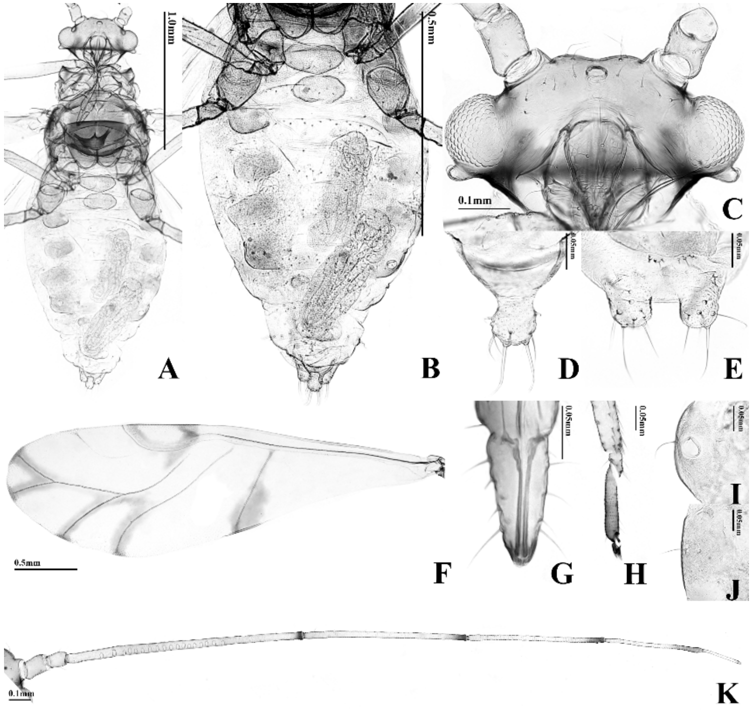


Fig. S61. Alate viviparous female of ***Shivaphis* (*Sinishivaphis*) *szelegiewiczi* Quednau, 1979 혹팽나무알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

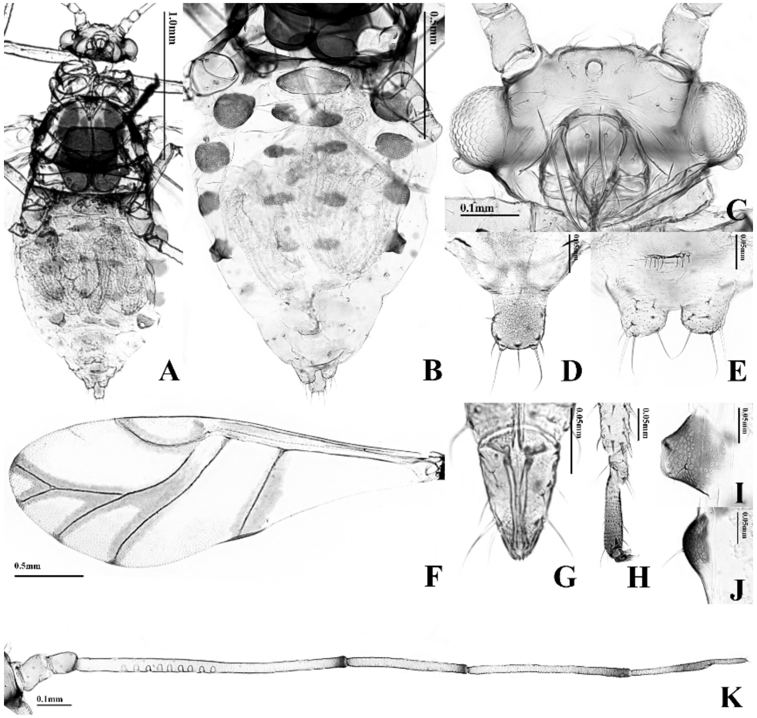


Fig. S62. Alate viviparous female of ***Shivaphis* (*Sinishivaphis*) *tilisucta* (Zhang, 1990) 짙은혹팽나무알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

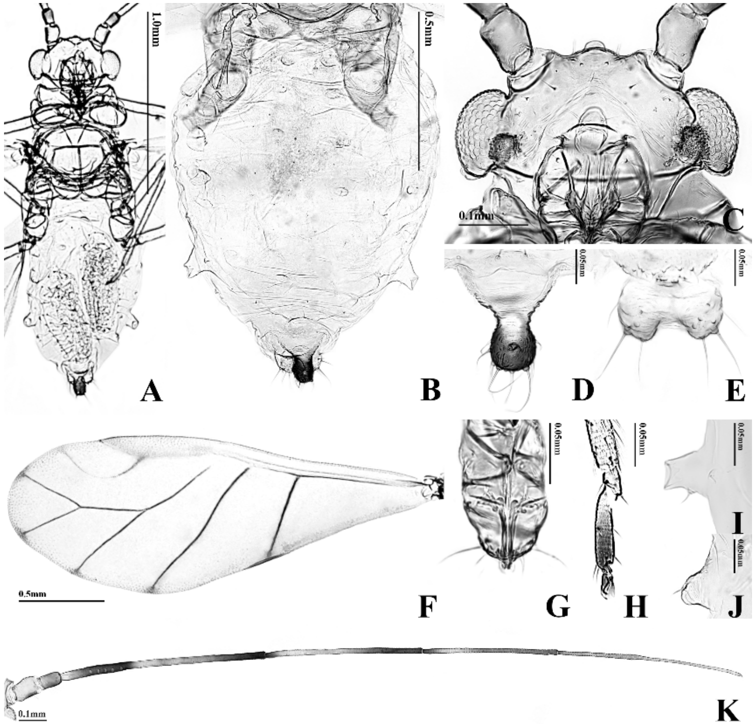


Fig. S63. Alate viviparous female of ***Takecallis arundicolens* (Clarke, 1903) 조릿대알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

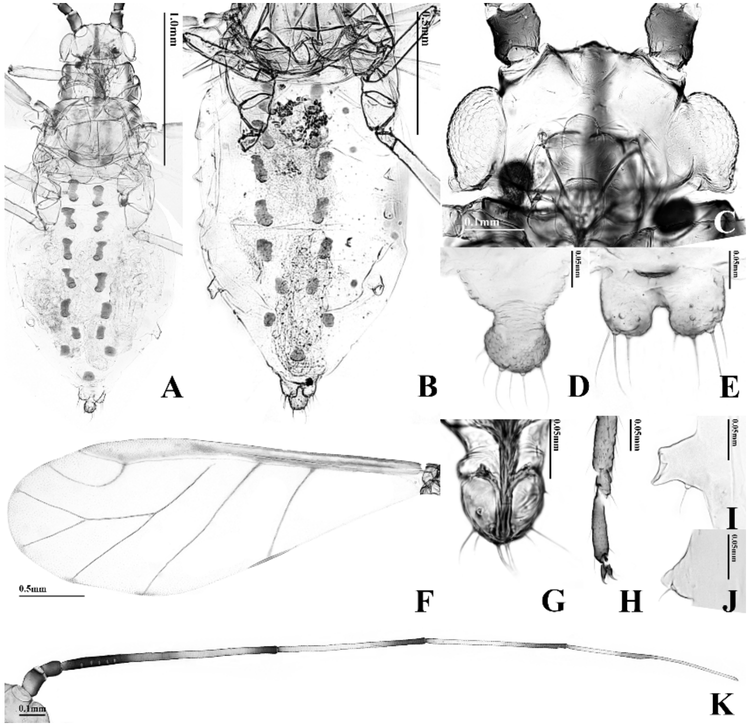


Fig. S64. Alate viviparous female of ***Takecallis arundinariae* (Essig, 1917) 대알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

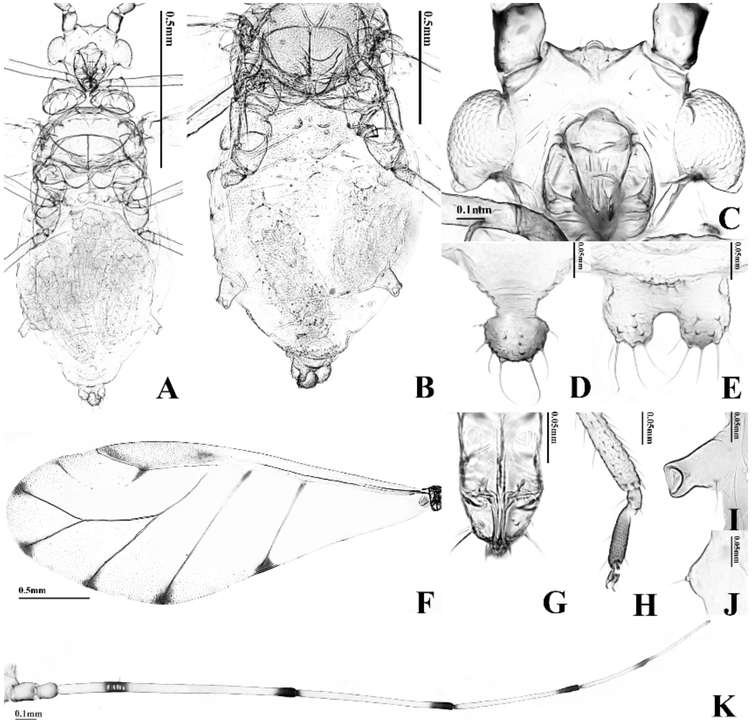


Fig. S65. Alate viviparous female of ***Takecallis longiantennata*** **Lee, sp. nov. 더듬이대알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

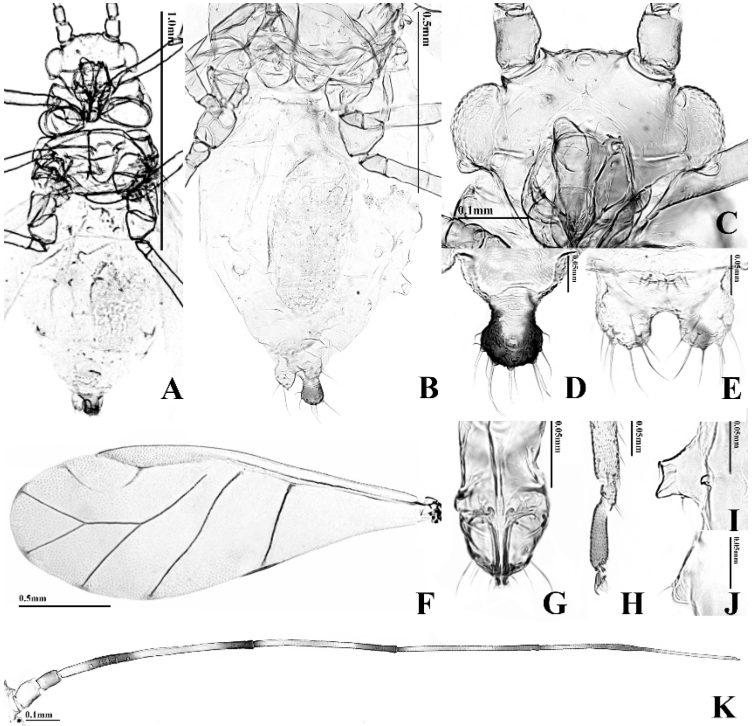


Fig. S66. Alate viviparous female of ***Takecallis obscura*** **Lee, sp. nov. 우리조릿대알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

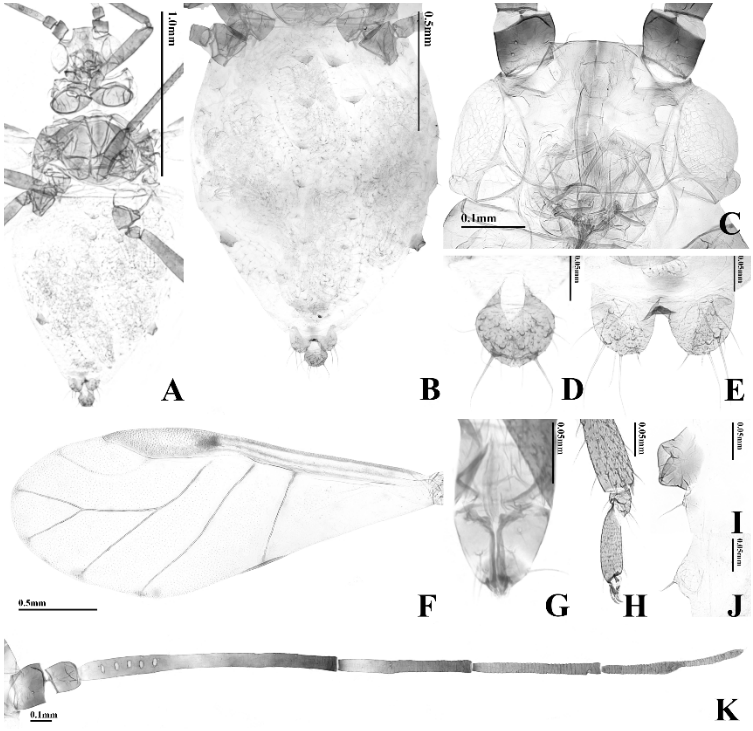


Fig. S67. Alate viviparous female of ***Takecallis taiwana* (Takahashi, 1926) 대만조릿대알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

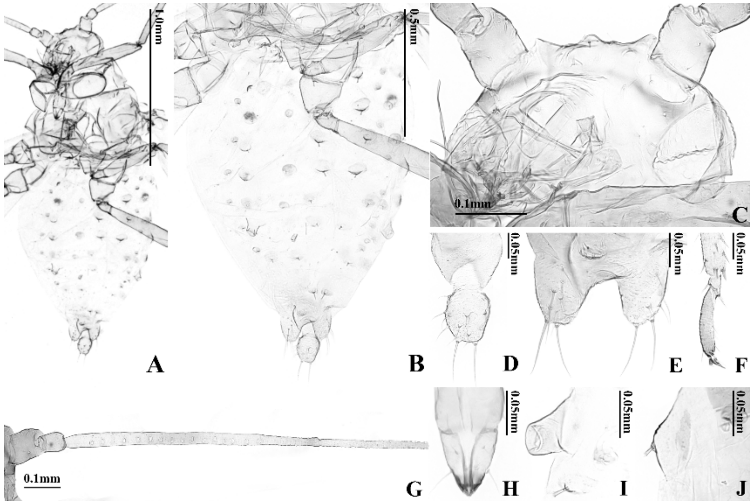


Fig. S68. Alate viviparous female of ***Therioaphis* (*Pterocallidium*) *subalba* Börner, 1949 싸리날개콩알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, 2HT; G, antenna; H, URS; I, SIPH; J, 4MT).

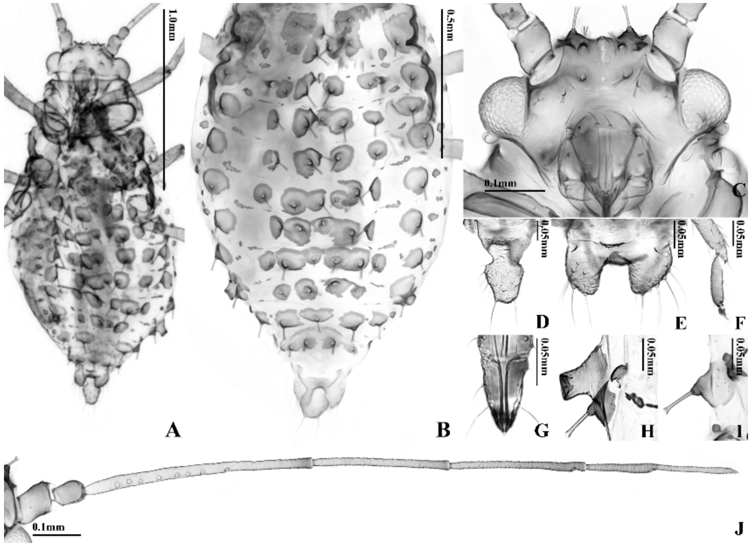


Fig. S69. Apterous viviparous female of ***Therioaphis* (*Pterocallidium*) *trifolii* (Monell, 1882) 콩알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, 2HT; G, URS; H, SIPH; I, 4MT; J, antenna).

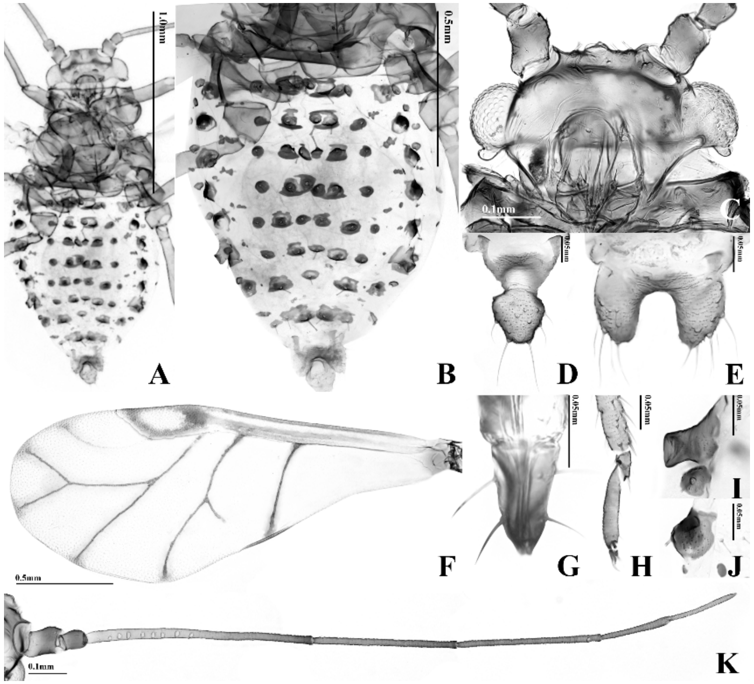


Fig. S69-2. Alate viviparous female of ***Therioaphis* (*Pterocallidium*) *trifolii* (Monell, 1882) 콩알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

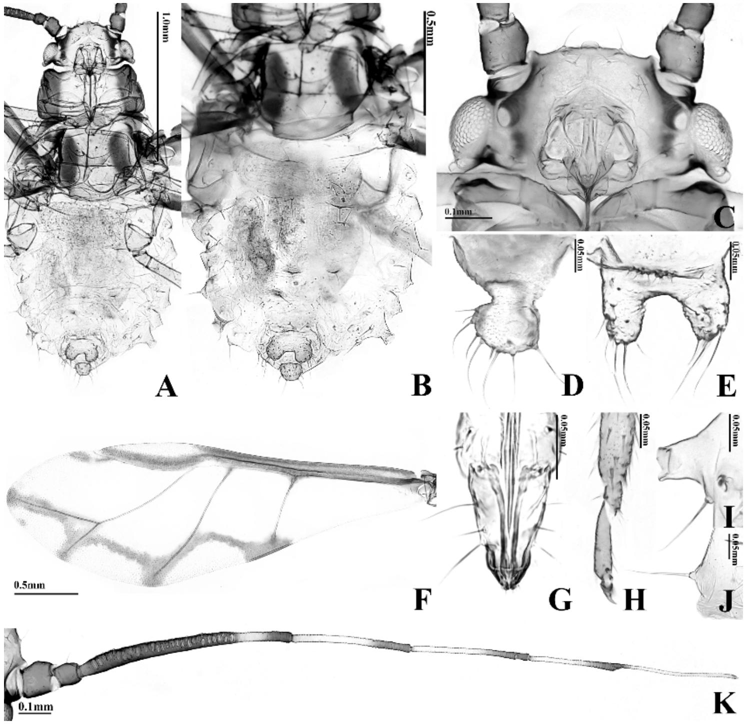


Fig. S70. Alate viviparous female of ***Tiliaphis coreana* Quednau, 1979 우리피나무알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

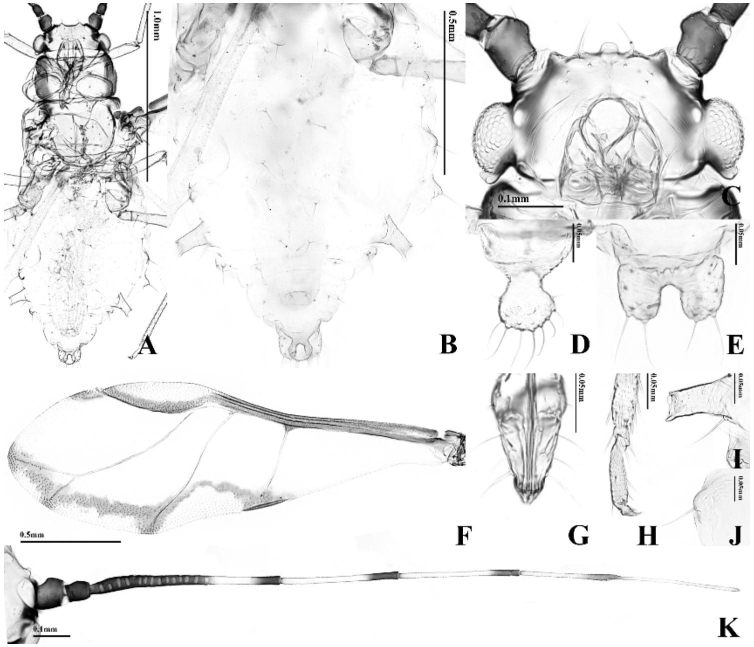


Fig. S71. Alate viviparous female of ***Tiliaphis pseudoshinae* Quednau, 1979 닮은참피나무알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

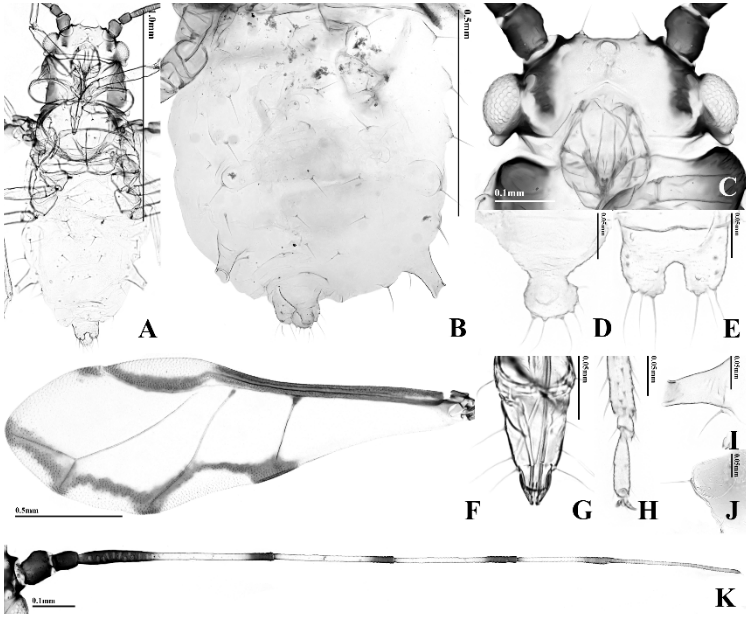


Fig. S72. Alate viviparous female of ***Tiliaphis shinae* (Shinji, 1924) 참피나무알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

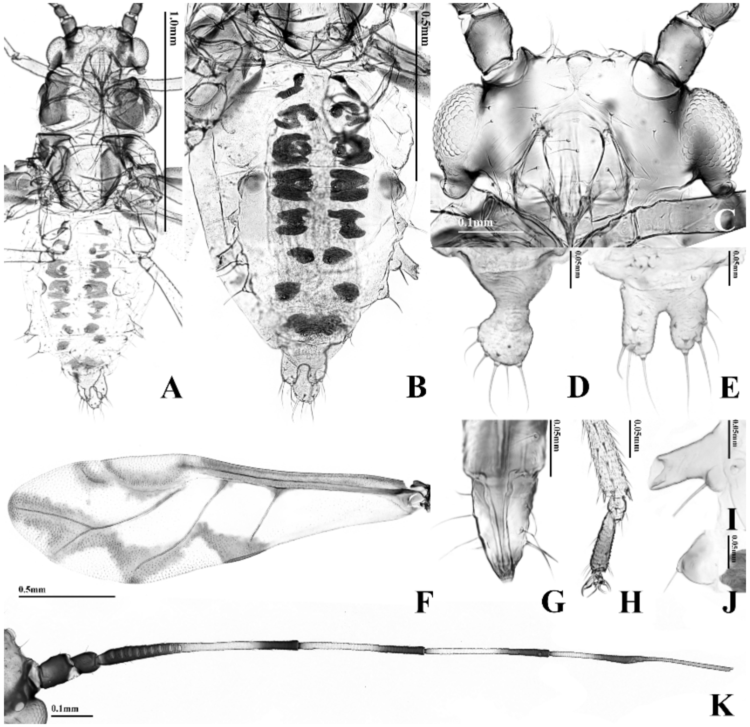


Fig. S73. Alate viviparous female of ***Tiliaphis shinjii* Higuchi, 1972 무늬피나무알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

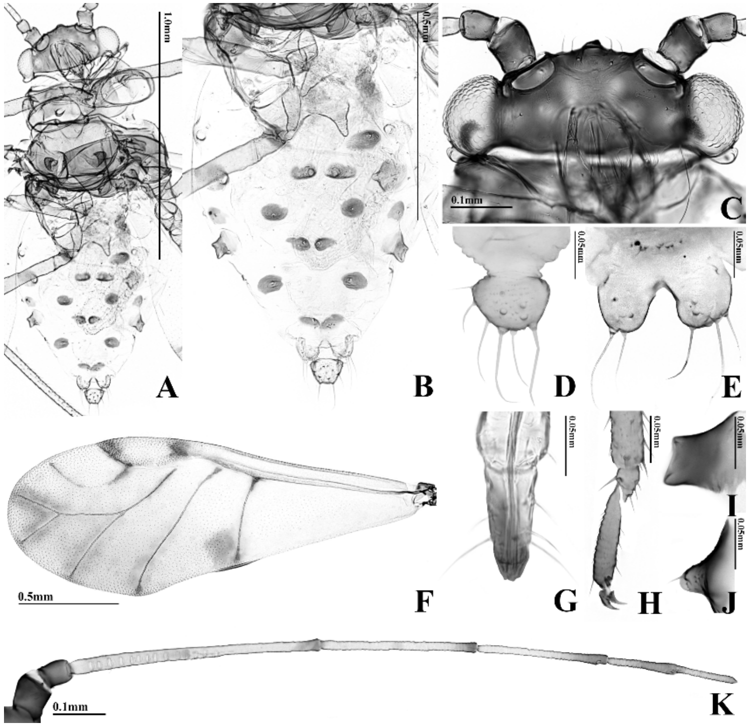


Fig. S74. Alate viviparous female of ***Tinocallis*** **(*Sappocallis*)** ***saltans*** **(Nevsky, 1929) 애느릅알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

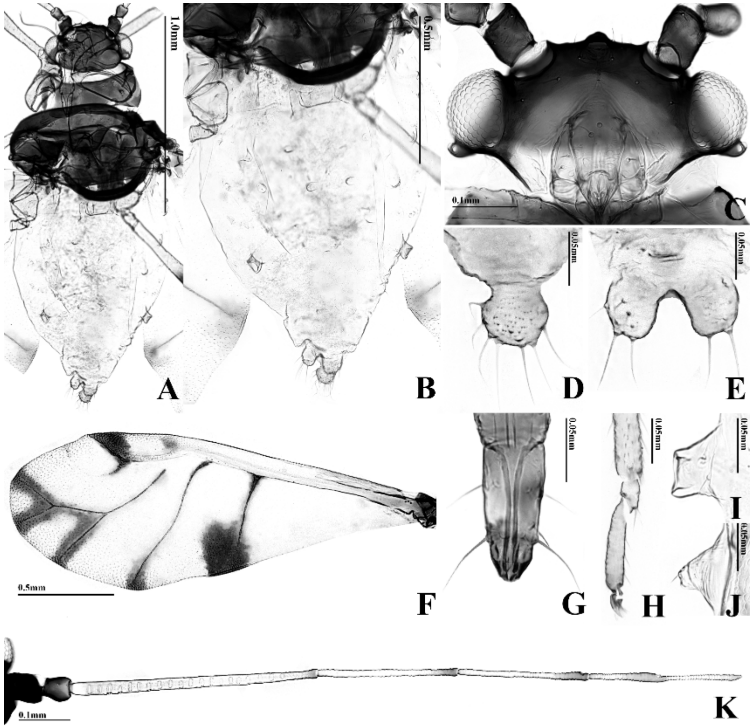


Fig. S75. Alate viviparous female of ***Tinocallis*** **(*Sappocallis*)** ***takachihoensis*** **Higuchi, 1972 별점느릅알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

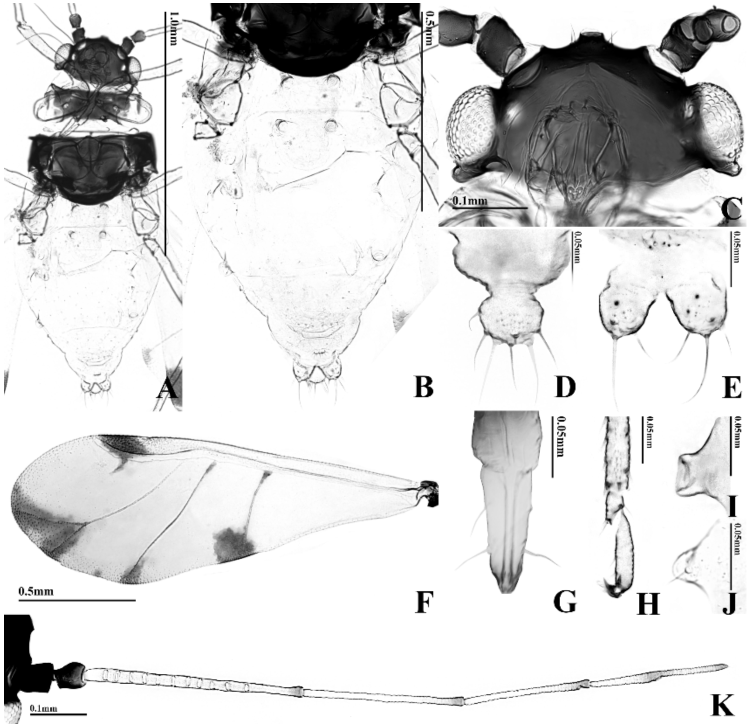


Fig. S76. Alate viviparous female of ***Tinocallis (Sappocallis) ulmicola* (Matsumura, 1919) 느릅알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

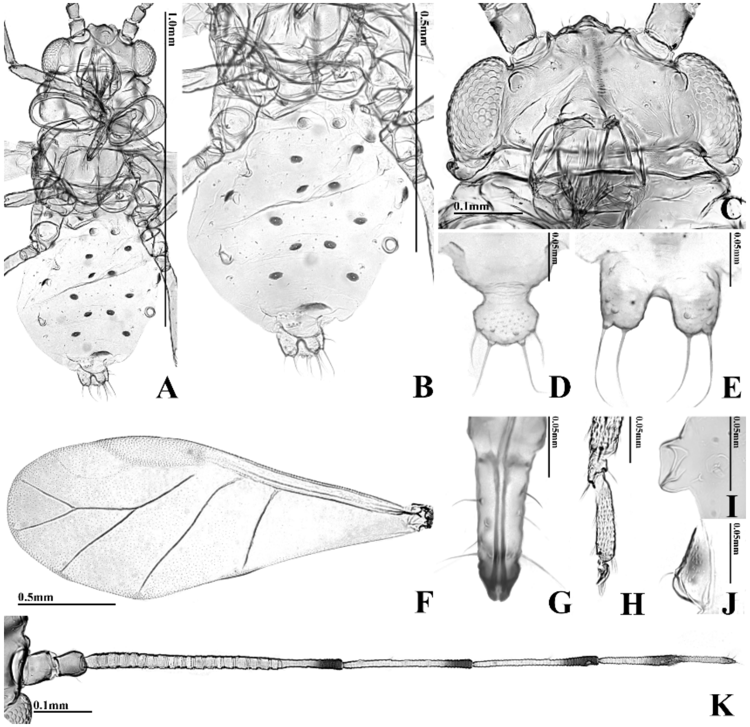


Fig. S77. Alate viviparous female of ***Tinocallis (Tinocallis) latifoliae* Lee, sp. nov. 둥근잎느티나무알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

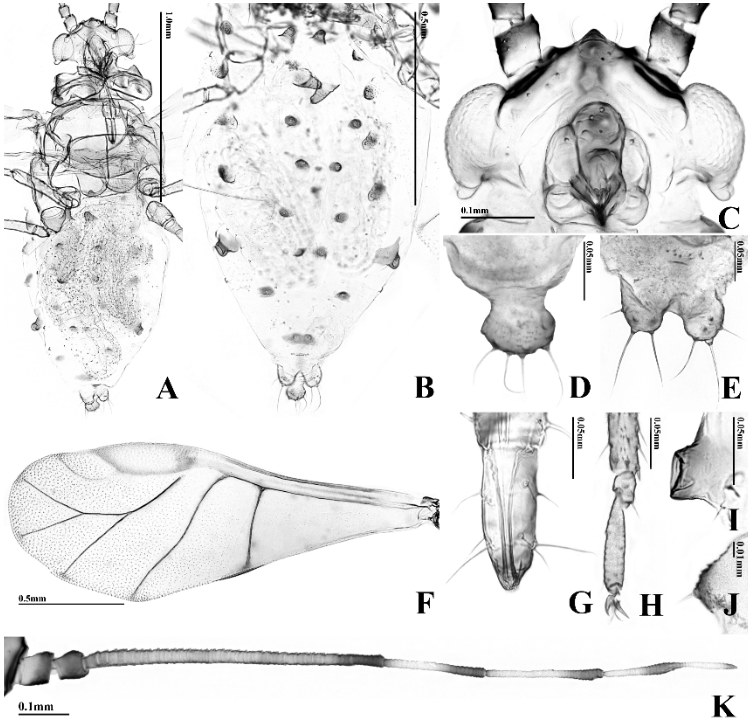


Fig. S78. Alate viviparous female of ***Tinocallis* (*Tinocallis*) *mushensis* (Takahashi, 1925) 노랑느티나무알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

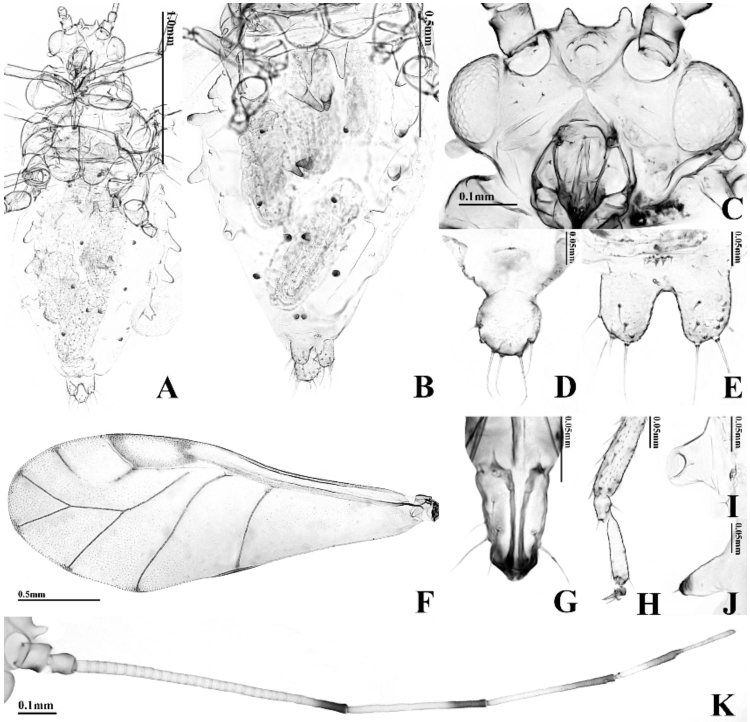


Fig. S79. Alate viviparous female of ***Tinocallis* (*Tinocallis*) *ulmiparvifoliae* Matsumura, 1919 머리혹알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

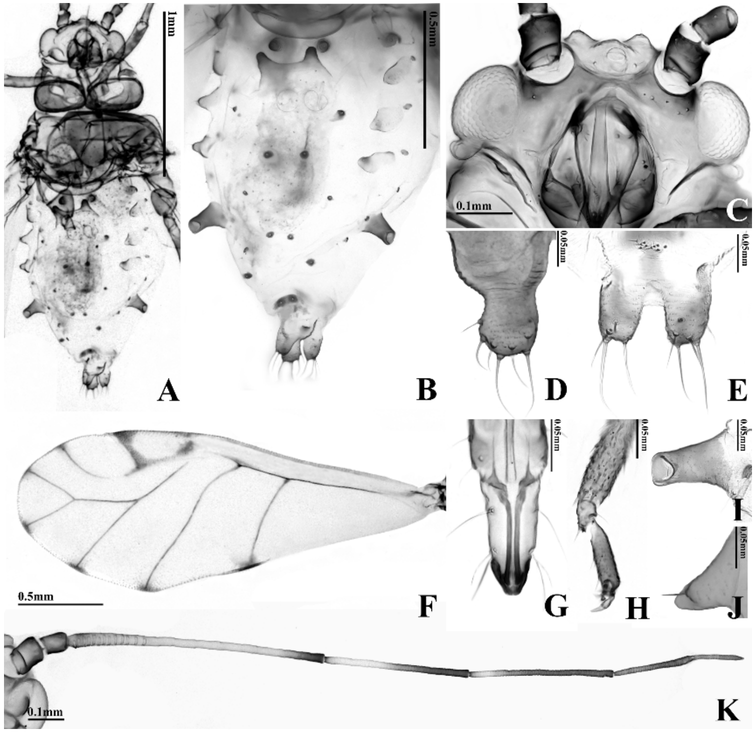


Fig. S80. Alate viviparous female of ***Tinocallis* (*Tinocallis*) *viridis* (Takahashi, 1929) 초록느티나무알락진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

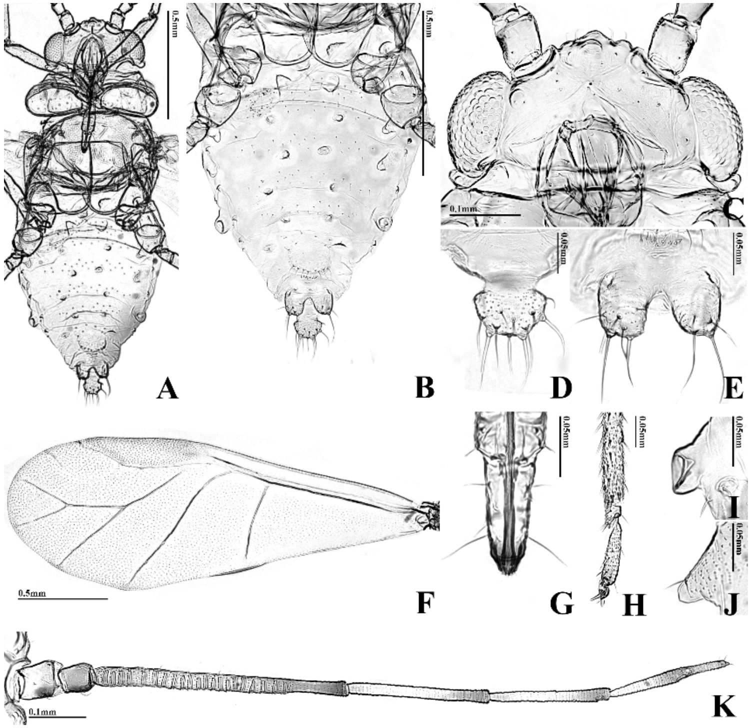


Fig. S81. Alate viviparous female of ***Tinocallis* (*Tinocallis*) *zelkowae* (Takahashi, 1929) 느티나무알락진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

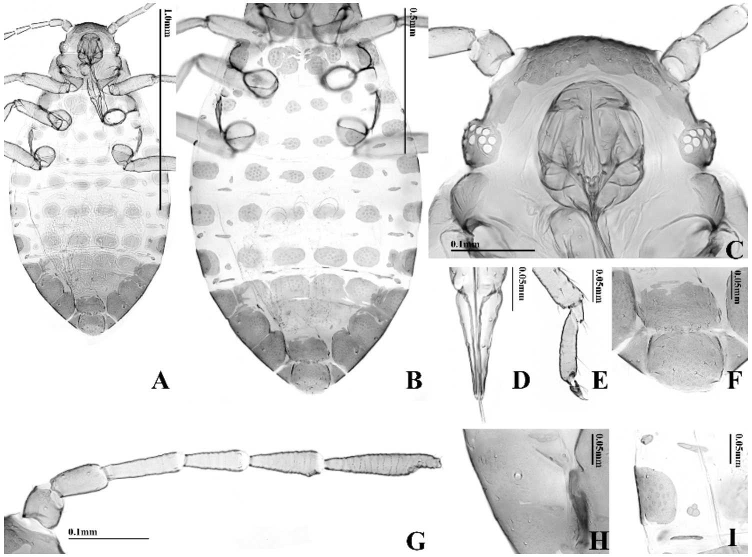


Fig. S82. Alate viviparous female of ***Diphyllaphis* (*Diphyllaphis*) *konarae* (Shinji, 1924) 둥글무늬가루진딧물 (신칭)** (A, body; B, abdomen; C, head; D, URS; E, 2HT; F, cauda and anal plate; G, antenna; H, SIPH; I, 4th margin).

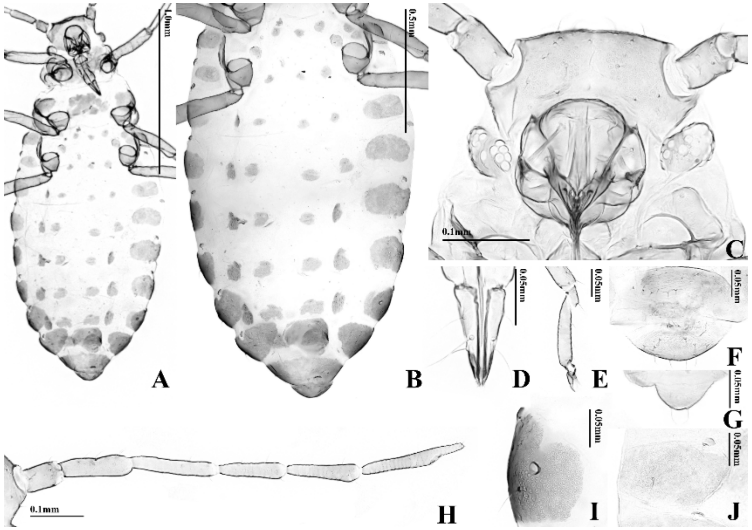
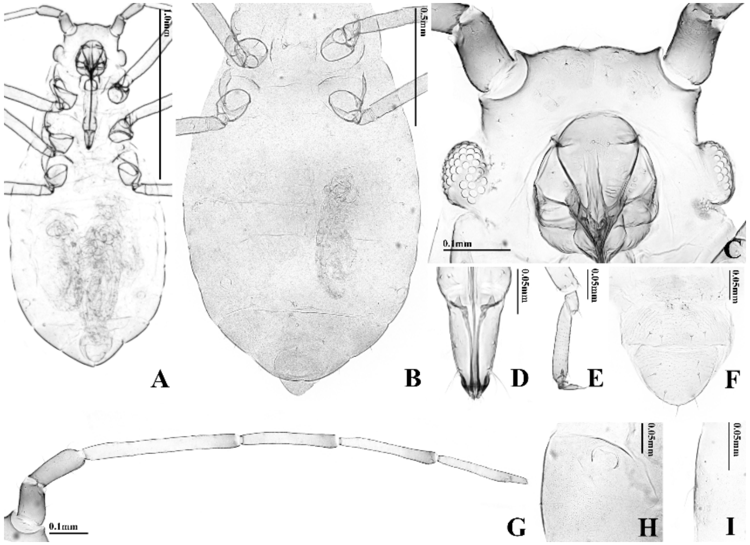


Fig. S83. Alate viviparous female of ***Diphyllaphis* (*Nymphaphis*) *quercus* (Takahashi, 1960) 갈참나무가루진딧물** (A, body; B, abdomen; C, head; D, URS; E, 2HT; F, anal plate; G, Cauda; H, antenna; I, SIPH; J, 4th margin).



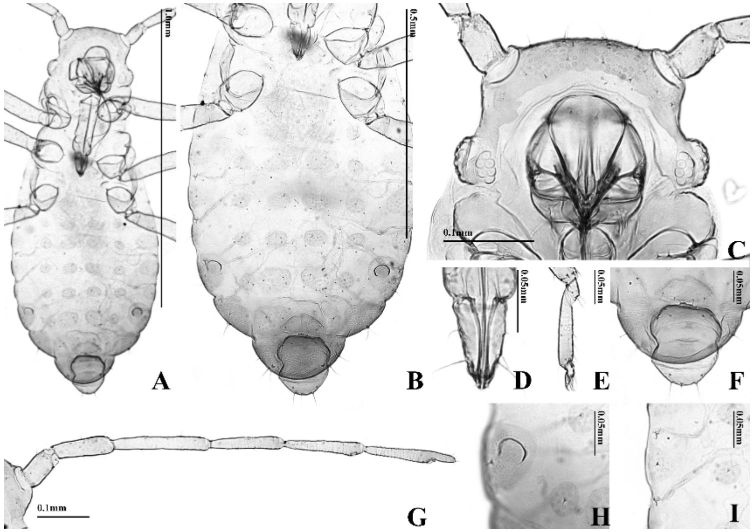


Fig. S84. Alate viviparous female of ***Machilaphis machili* Takahashi, 1960 후박나무가루진딧물** (A, body; B, abdomen; C, head; D, URS; E, 2HT; F, cauda and anal plate; G, antenna; H, SIPH; I, 4th margin).

Fig. S85. Alate viviparous female of ***Phyllaphis fagifoliae* Takahashi, 1919 너도밤나무가루진딧물** (A, body; B, abdomen; C, head; D, URS; E, 2HT; F, cauda and anal plate; G, antenna; H, SIPH; I, 4th margin).

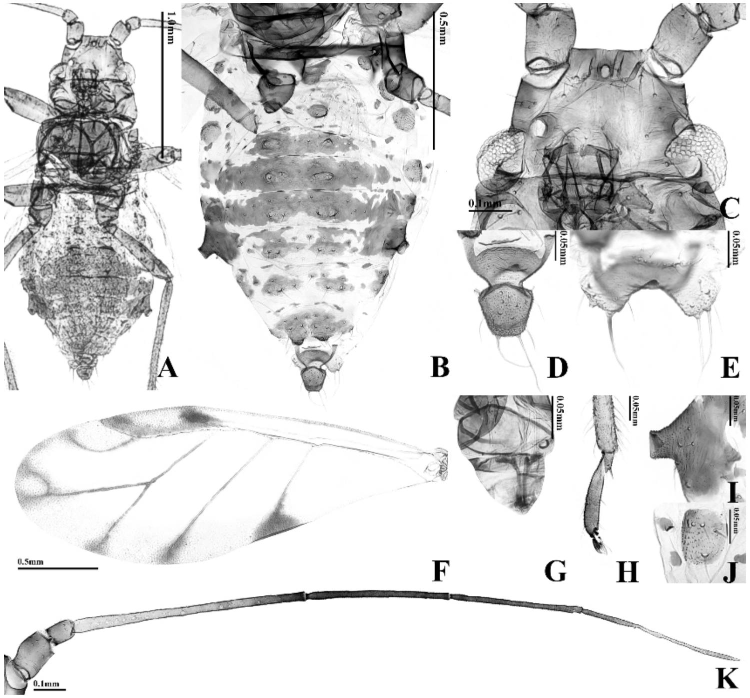


Fig. S86. Alate viviparous female of ***Saltusaphis tuberculata* Quednau & Lee, 2001 사초혹진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4MT; K, antenna).

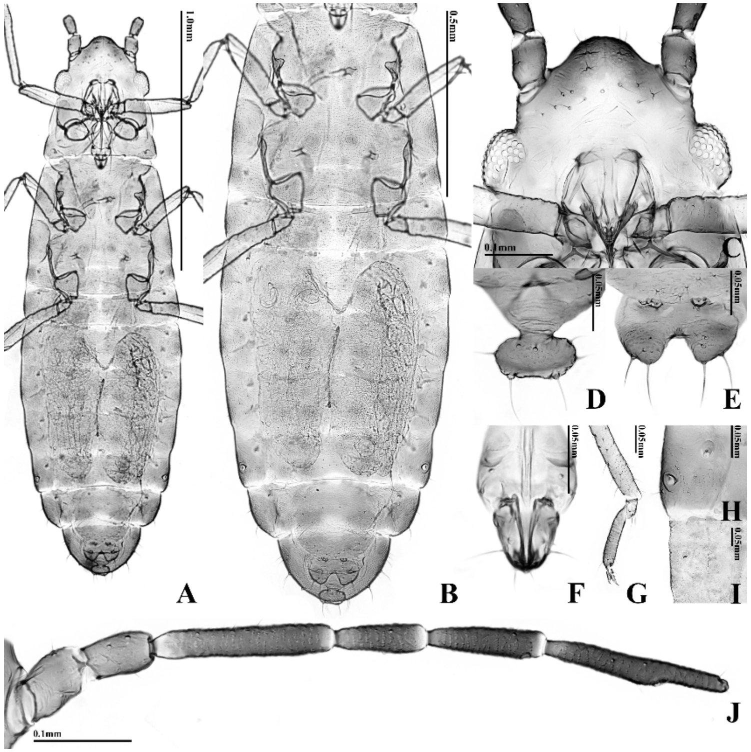


Fig. S87. Apterous viviparous female of ***Allaphis ossiannilssonia* (Hille Ris Lambers. 1952) 긴총채진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, URE; G, 2HT; H, SIPH; I, 4th margin; J, antenna).

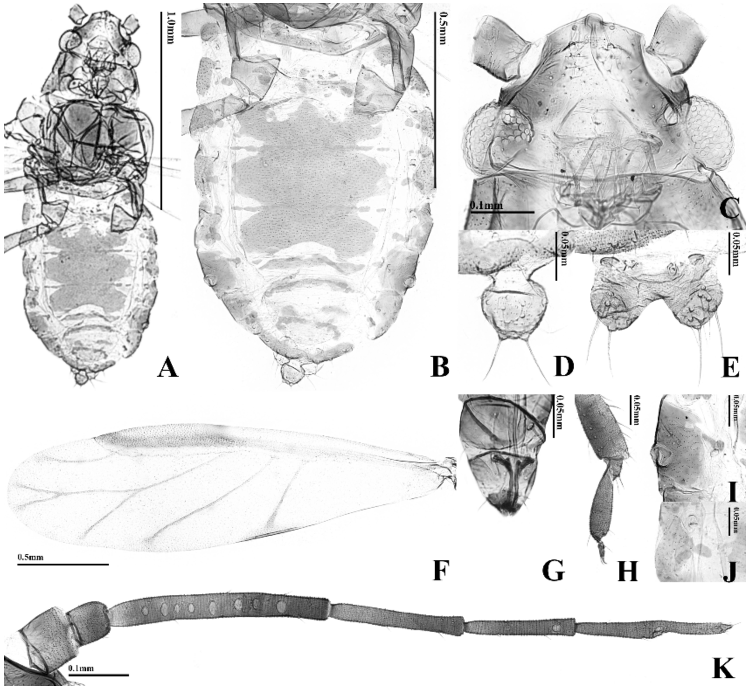


Fig. S88. Alate viviparous female of ***Subsaltusaphis virginica* Baker, 1917 벼룩진딧물** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, fore wing; G, URS; H, 2HT; I, SIPH; J, 4th margin; K, antenna).

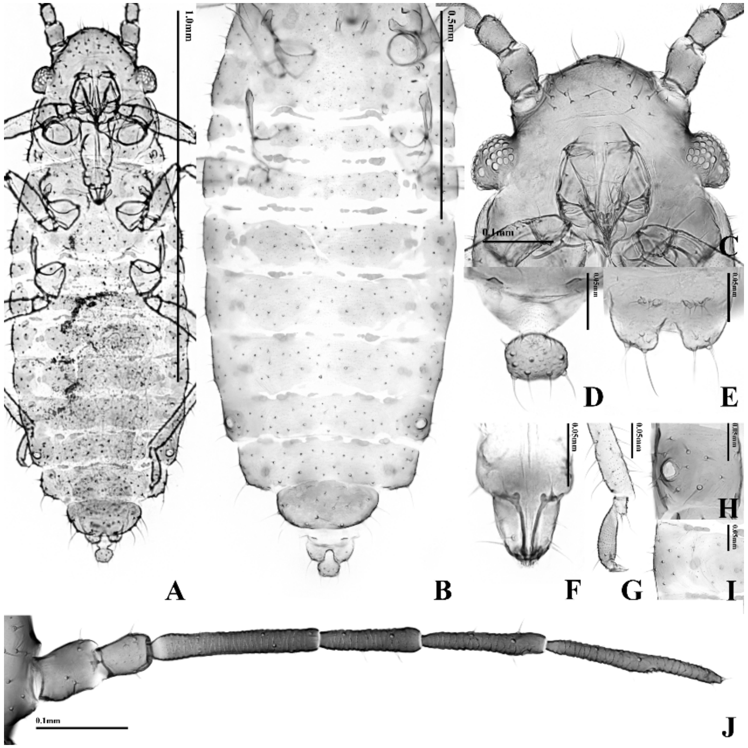


Fig. S89. Apterous viviparous female of ***Thripsaphis ballii caspitosae* Richards, 1917 제주총채진딧물 (신칭)** (A, body; B, abdomen; C, head; D, cauda; E, anal plate; F, URS; G, 2HT; H, SIPH; I, 4th margin; J, antenna).

Appendix II. Biometric data

Table S1. Biometric data of Betacallis alnicolens Matsumura from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	3.32 (3.06-3.49)
	Whole Antennae	5.24 (5.01-5.58)
	Ant.I	0.15 (0.14-0.16)
	Ant.II	0.12 (0.11-0.12)
	Ant.III	1.60 (1.46-1.70)
	Ant.IV	1.18 (1.09-1.30)
	Ant.V	1.02 (0.93-1.12)
	Ant.VIb	0.39 (0.38-0.43)
	PT	0.77 (0.75-0.80)
	URS	0.15 (0.15-0.17)
	HFM	1.32 (1.22-1.43)
	HTB	2.53 (2.34-2.78)
	2HT	0.16 (0.15-0.18)
	SIPH	0.18 (0.14-0.20)
	Cauda	0.18 (0.16-0.20)
	Longest setae on Ant.III	0.02 (0.01-0.03)
No. of setae on	Ant.I	4 (3-5)
	Ant.II	4 (3-5)
	Ant.III	31 (26-37)
	Ant.VIb	1
	URS (accessory setae)	12 (11-13)
	SIPH	0
	8th abdominal tergite	8 (6-9)
	Cauda knob	8 (6-11)
	Each lobe of anal plate	12 (10-14)
No. of rhinaria on	Ant.III	23 (20-28)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.58 (1.52-1.64)
	PT / Ant.VIb	1.97 (1.74-2.11)
	PT / Ant.III	0.48 (0.44-0.53)
	URS / 2HT	0.94 (0.88-1.00)
	URS / Ant.VIb	0.39 (0.38-0.40)
	SIPH / Body length	0.05 (0.05-0.06)
	SIPH / Ant.III	0.11 (0.10-0.13)
	SIPH / HFM	0.13 (0.11-0.15)
	SIPH / Cauda	0.95 (0.88-1.00)
	Setae on Ant.III / BDAnt.III	0.33 (0.17-0.50)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S2. Biometric data of Betacallis trilinatae Lee sp. nov. from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.31 (2.07-2.59)
	Whole Antennae	3.38 (2.99-3.72)
	Ant.I	0.11 (0.10-0.11)
	Ant.II	0.09 (0.08-0.10)
	Ant.III	1.10 (0.99-1.22)
	Ant.IV	0.77 (0.67-0.88)
	Ant.V	0.64 (0.55-0.73)
	Ant.VIb	0.25 (0.23-0.27)
	PT	0.42 (0.36-0.47)
	URS	0.14 (0.14-0.15)
	HFM	0.80 (0.67-0.91)
	HTB	1.62 (1.43-1.82)
	2HT	0.13 (0.12-0.14)
	SIPH	0.13 (0.10-0.15)
	Cauda	0.12 (0.11-0.13)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	6 (5-6)
	Ant.II	5
	Ant.III	34 (30-37)
	Ant.VIb	1
	URS (accessory setae)	8 (7-8)
	SIPH	0
	8th abdominal tergite	6
	Cauda knob	8 (7-9)
	Each lobe of anal plate	9 (8-9)
No. of rhinaria on	Ant.III	27 (24-30)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.46 (1.43-1.52)
	PT / Ant.VIb	1.70 (1.57-1.77)
	PT / Ant.III	0.38 (0.36-0.40)
	URS / 2HT	1.10 (1.00-1.17)
	URS / Ant.VIb	0.58 (0.56-0.61)
	SIPH / Body length	0.06 (0.05-0.07)
	SIPH / Ant.III	0.12 (0.10-0.14)
	SIPH / HFM	0.17 (0.14-0.20)
	SIPH / Cauda	1.11 (0.91-1.25)
	Setae on Ant.III / BDAnt.III	0.24 (0.20-0.25)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S3. Biometric data of *Betulaphis quadrituberculata* Kaltenbach from Korea

	Body parts	Apterous viviparous female (n=3)
Length (mm)	Body length	1.54 (1.50-1.61)
	Whole Antennae	0.85 (0.84-0.87)
	Ant.I	0.07 (0.06-0.07)
	Ant.II	0.04 (0.04-0.05)
	Ant.III	0.27 (0.26-0.28)
	Ant.IV	0.15 (0.14-0.16)
	Ant.V	0.12 (0.11-0.13)
	Ant.VIb	0.09 (0.09-0.10)
	PT	0.11 (0.10-0.11)
	URS	0.08 (0.07-0.09)
	HFM	0.32 (0.27-0.37)
	HTB	0.56 (0.48-0.62)
	2HT	0.11 (0.10-0.11)
	SIPH	0.09 (0.07-0.11)
	Cauda	0.08 (0.07-0.10)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	4
	Ant.II	4 (3-4)
	Ant.III	7 (6-8)
	Ant.VIb	1
	URS (accessory setae)	5 (4-6)
	SIPH	0
	8th abdominal tergite	5 (5-6)
	Cauda knob	7 (6-8)
	Each lobe of anal plate	8 (7-8)
No. of rhinaria on	Ant.III	0
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.55 (0.54-0.56)
	PT / Ant.VIb	1.15 (1.00-1.22)
	PT / Ant.III	0.40 (0.36-0.42)
	URS / 2HT	0.78 (0.70-0.82)
	URS / Ant.VIb	0.89 (0.78-1.00)
	SIPH / Body length	0.06 (0.05-0.07)
	SIPH / Ant.III	0.32 (0.27-0.39)
	SIPH / HFM	0.27 (0.21-0.30)
	SIPH / Cauda	0.74 (0.54-1.00)
	Setae on Ant.III / BDAnt.III	0.44 (0.33-0.50)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S4. Biometric data of *Boernerina occidentalis* (Hille Ris Lambers & Hottes) from Korea

	Body parts	Apterous viviparous female (n=2)
Length (mm)	Body length	2.45 (2.42-2.48)
	Whole Antennae	0.48 (0.47-0.48)
	Ant.I	0.10
	Ant.II	0.08 (0.07-0.08)
	Ant.III	0.37 (0.36-0.37)
	Ant.IV	0.21 (0.19-0.23)
	Ant.V	0.21 (0.20-0.21)
	Ant.VIb	0.11 (0.10-0.11)
	PT	0.11
	URS	0.14
	HFM	0.58 (0.57-0.59)
	HTB	0.89 (0.87-0.90)
	2HT	0.13
	SIPH	0.07
	Cauda	0.14 (0.13-0.14)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	7 (6-8)
	Ant.II	5 (4-5)
	Ant.III	11 (10-12)
	Ant.VIb	1
	URS (accessory setae)	7
	SIPH	0
	8th abdominal tergite	8
	Cauda knob	13 (12-14)
	Each lobe of anal plate	10 (9-10)
No. of rhinaria on	Ant.III	0
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.48 (0.47-0.48)
	PT / Ant.VIb	1.05 (1.00-1.10)
	PT / Ant.III	0.30 (0.30-0.31)
	URS / 2HT	1.08
	URS / Ant.VIb	1.34 (1.27-1.40)
	SIPH / Body length	0.03
	SIPH / Ant.III	0.19
	SIPH / HFM	0.12
	SIPH / Cauda	0.52 (0.50-0.54)
	Setae on Ant.III / BDAnt.III	0.25

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S5. Biometric data of *Calaphis magnolia* Essig & Kuwana from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.47 (1.16-1.66)
	Whole Antennae	2.40 (2.21-2.62)
	Ant.I	0.11 (0.10-0.11)
	Ant.II	0.05 (0.04-0.05)
	Ant.III	0.55 (0.52-0.63)
	Ant.IV	0.31 (0.26-0.38)
	Ant.V	0.27 (0.22-0.32)
	Ant.VIb	0.19 (0.17-0.24)
	PT	0.93 (0.88-1.10)
	URS	0.06 (0.06-0.07)
	HFM	0.40 (0.38-0.43)
	HTB	0.75 (0.70-0.80)
	2HT	0.10 (0.10-0.11)
	SIPH	0.06 (0.05-0.07)
	Cauda	0.09 (0.08-0.10)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	5 (5-6)
	Ant.II	3 (2-3)
	Ant.III	9 (8-10)
	Ant.VIb	1
	URS (accessory setae)	3 (3-4)
	SIPH	0
	8th abdominal tergite	6 (5-6)
	Cauda knob	8 (6-9)
	Each lobe of anal plate	11 (9-13)
No. of rhinaria on	Ant.III	8 (6-11)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.66 (1.33-1.96)
	PT / Ant.VIb	4.95 (3.71-6.11)
	PT / Ant.III	1.69 (1.41-2.08)
	URS / 2HT	0.61 (0.55-0.70)
	URS / Ant.VIb	0.33 (0.25-0.39)
	SIPH / Body length	0.04 (0.04-0.05)
	SIPH / Ant.III	0.12 (0.09-0.13)
	SIPH / HFM	0.16 (0.13-0.18)
	SIPH / Cauda	0.71 (0.50-0.88)
	Setae on Ant.III / BDAnt.III	0.33

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S6. Biometric data of *Calaphis similis* Quednau from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.62 (2.05-3.03)
	Whole Antennae	3.75 (2.79-4.23)
	Ant.I	0.15 (0.12-0.17)
	Ant.II	0.09 (0.08-0.11)
	Ant.III	1.29 (1.02-1.48)
	Ant.IV	0.79 (0.57-0.91)
	Ant.V	0.62 (0.43-0.71)
	Ant.VIb	0.28 (0.20-0.32)
	PT	0.54 (0.37-0.63)
	URS	0.13 (0.13-0.14)
	HFM	0.96 (0.73-1.12)
	HTB	1.85 (1.19-2.16)
	2HT	0.14 (0.13-0.15)
	SIPH	0.13 (0.11-0.17)
	Cauda	0.18 (0.16-0.19)
	Longest setae on Ant.III	0.02 (0.01-0.02)
No. of setae on	Ant.I	8 (6-10)
	Ant.II	5 (4-7)
	Ant.III	37 (33-41)
	Ant.VIb	1
	URS (accessory setae)	10 (8-12)
	SIPH	0
	8th abdominal tergite	7 (6-8)
	Cauda knob	7 (6-8)
	Each lobe of anal plate	11 (10-13)
No. of rhinaria on	Ant.III	21 (18-23)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.44 (1.31-1.79)
	PT / Ant.VIb	1.93 (1.66-2.10)
	PT / Ant.III	0.41 (0.36-0.48)
	URS / 2HT	0.95 (0.87-1.00)
	URS / Ant.VIb	0.49 (0.41-0.65)
	SIPH / Body length	0.05 (0.04-0.06)
	SIPH / Ant.III	0.10 (0.09-0.11)
	SIPH / HFM	0.14 (0.12-0.15)
	SIPH / Cauda	0.73 (0.68-0.89)
	Setae on Ant.III / BDAnt.III	0.37 (0.25-0.40)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S7. Biometric data of *Callipterinella calliptera* (Hartig) from Korea

	Body parts	Apterous viviparous female (n=20)
Length (mm)	Body length	1.71 (1.55-1.80)
	Whole Antennae	1.03 (0.96-1.06)
	Ant.I	0.07
	Ant.II	0.05 (0.05-0.06)
	Ant.III	0.34 (0.32-0.38)
	Ant.IV	0.17 (0.15-0.18)
	Ant.V	0.14 (0.13-0.15)
	Ant.VIb	0.09
	PT	0.17 (0.15-0.21)
	URS	0.11 (0.10-0.12)
	HFM	0.42 (0.39-0.44)
	HTB	0.66 (0.64-0.70)
	2HT	0.12 (0.11-0.13)
	SIPH	0.07 (0.06-0.08)
	Cauda	0.08 (0.06-0.09)
	Longest setae on Ant.III	0.02
No. of setae on	Ant.I	4 (4-5)
	Ant.II	4 (4-5)
	Ant.III	14 (12-16)
	Ant.VIb	1
	URS (accessory setae)	8 (6-10)
	SIPH	0
	8th abdominal tergite	8 (7-9)
	Cauda knob	7 (6-9)
	Each lobe of anal plate	10 (8-12)
No. of rhinaria on	Ant.III	5 (4-7)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.61 (0.57-0.68)
	PT / Ant.VIb	1.87 (1.67-2.33)
	PT / Ant.III	0.50 (0.42-0.66)
	URS / 2HT	0.89 (0.77-1.00)
	URS / Ant.VIb	1.22 (1.11-1.33)
	SIPH / Body length	0.04 (0.04-0.05)
	SIPH / Ant.III	0.22 (0.19-0.25)
	SIPH / HFM	0.18 (0.15-0.21)
	SIPH / Cauda	0.94 (0.78-1.14)
	Setae on Ant.III / BDAnt.III	0.67

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S8. Biometric data of *Callipterinella tuberculata* (von Heyden) from Korea

	Body parts	Apterous viviparous female (n=4)
Length (mm)	Body length	1.98 (1.48-2.16)
	Whole Antennae	1.72 (1.62-1.76)
	Ant.I	0.08 (0.07-0.09)
	Ant.II	0.06 (0.06-0.08)
	Ant.III	0.57 (0.55-0.59)
	Ant.IV	0.28 (0.26-0.28)
	Ant.V	0.25 (0.23-0.26)
	Ant.VIb	0.13 (0.11-0.14)
	PT	0.35 (0.32-0.38)
	URS	0.13 (0.12-0.14)
	HFM	0.55 (0.45-0.59)
	HTB	0.93 (0.74-1.02)
	2HT	0.14 (0.13-0.15)
	SIPH	0.08
	Cauda	0.06 (0.05-0.06)
	Longest setae on Ant.III	0.03 (0.02-0.03)
No. of setae on	Ant.I	5 (4-6)
	Ant.II	4
	Ant.III	17 (16-18)
	Ant.VIb	1
	URS (accessory setae)	7 (6-8)
	SIPH	0
	8th abdominal tergite	10 (9-11)
	Cauda knob	10 (8-14)
	Each lobe of anal plate	12 (9-14)
No. of rhinaria on	Ant.III	6 (6-7)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.81 (0.81-0.82)
	PT / Ant.VIb	2.71 (2.62-2.91)
	PT / Ant.III	0.61 (0.58-0.69)
	URS / 2HT	0.93 (0.87-1.00)
	URS / Ant.VIb	1.07 (0.93-1.18)
	SIPH / Body length	0.04
	SIPH / Ant.III	0.14 (0.14-0.15)
	SIPH / HFM	0.15 (0.14-0.18)
	SIPH / Cauda	1.44 (1.33-1.60)
	Setae on Ant.III / BDAnt.III	0.81 (0.50-1.00)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S9. Biometric data of *Clethrobius comes* (Walker) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	4.01 (3.76-4.24)
	Whole Antennae	3.60 (3.38-3.76)
	Ant.I	0.17 (0.15-0.18)
	Ant.II	0.12 (0.10-0.13)
	Ant.III	1.41 (1.35-1.48)
	Ant.IV	0.81 (0.74-0.90)
	Ant.V	0.66 (0.56-0.72)
	Ant.VIb	0.25 (0.24-0.26)
	PT	0.18 (0.15-0.19)
	URS	0.13 (0.09-0.15)
	HFM	1.38 (1.28-1.51)
	HTB	2.55 (2.23-2.89)
	2HT	0.19 (0.18-0.20)
	SIPH	0.12 (0.11-0.14)
	Cauda	0.19 (0.18-0.21)
	Longest setae on Ant.III	0.11 (0.09-0.13)
No. of setae on	Ant.I	15 (14-16)
	Ant.II	8 (7-10)
	Ant.III	46 (43-51)
	Abt.VIb	1
	URS (accessory setae)	20 (18-22)
	SIPH	0
	8th abdominal tergite	(20-22)
	Cauda knob	21 (16-26)
	Anal plate	21 (18-23)
No. of rhinaria on	Ant.III	45 (38-52)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.90 (0.85-1.00)
	PT / Ant.VIb	0.70 (0.60-0.79)
	PT / Ant.III	0.13 (0.10-0.14)
	URS / 2HT	0.70 (0.45-0.83)
	URS / Ant.VIb	0.53 (0.36-0.63)
	SIPH / Body length	0.03
	SIPH / Ant.III	0.09 (0.08-0.10)
	SIPH / HFM	0.09 (0.08-0.10)
	SIPH / Cauda	0.65 (0.57-0.78)
	Setae on Ant.III / BDAnt.III	1.79 (1.50-2.20)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S10. Biometric data of *Euceraphis caerulescens* Pashtshenko from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	4.49 (3.77-4.96)
	Whole Antennae	5.73 (5.60-5.91)
	Ant.I	0.20 (0.18-0.22)
	Ant.II	0.14 (0.13-0.16)
	Ant.III	2.15 (2.03-2.28)
	Ant.IV	1.36 (1.24-1.52)
	Ant.V	1.17 (1.08-1.23)
	Ant.VIb	0.42 (0.40-0.45)
	PT	0.29 (0.26-0.32)
	URS	0.15 (0.13-0.16)
	HFM	1.99 (1.94-2.08)
	HTB	3.79 (3.64-3.93)
	2HT	0.23 (0.21-0.25)
	SIPH	0.17 (0.16-0.19)
	Cauda	0.25 (0.24-0.26)
	Longest setae on Ant.III	0.03 (0.02-0.04)
No. of setae on	Ant.I	13 (11-14)
	Ant.II	7 (6-9)
	Ant.III	64 (50-85)
	Ant.VIb	1
	URS (accessory setae)	9 (8-11)
	SIPH	0
	8th abdominal tergite	7 (6-9)
	Cauda knob	14 (12-16)
	Anal plate	11 (10-12)
No. of rhinaria on	Ant.III	35 (30-38)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.29 (1.16-1.49)
	PT / Ant.VIb	0.70 (0.64-0.78)
	PT / Ant.III	0.14 (0.13-0.15)
	URS / 2HT	0.64 (0.59-0.71)
	URS / Ant.VIb	0.35 (0.33-0.38)
	SIPH / Body length	0.04 (0.03-0.05)
	SIPH / Ant.III	0.08 (0.07-0.09)
	SIPH / HFM	0.09 (0.08-0.10)
	SIPH / Cauda	0.68 (0.64-0.76)
	Setae on Ant.III / BDAnt.III	0.43 (0.29-0.57)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S11. Biometric data of *Euceraphis nigra* Lee, sp. nov. from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	3.52 (3.34-3.67)
	Whole Antennae	4.28 (3.84-4.98)
	Ant.I	0.16 (0.15-0.18)
	Ant.II	0.12 (0.10-0.13)
	Ant.III	1.61 (1.48-1.78)
	Ant.IV	0.98 (0.88-1.17)
	Ant.V	0.85 (0.72-1.06)
	Ant.VIb	0.34 (0.30-0.42)
	PT	0.23 (0.19-0.28)
	URS	0.15 (0.14-0.16)
	HFM	1.46 (1.38-1.60)
	HTB	2.73 (2.39-3.02)
	2HT	0.21 (0.20-0.21)
	SIPH	0.12 (0.11-0.13)
	Cauda	0.21 (0.19-0.25)
	Longest setae on Ant.III	0.03 (0.02-0.03)
No. of setae on	Ant.I	10 (8-11)
	Ant.II	7 (6-8)
	Ant.III	47 (41-54)
	Ant.VIb	1
	URS (accessory setae)	9 (8-10)
	SIPH	0
	8th abdominal tergite	8 (7-8)
	Cauda knob	12 (11-13)
	Anal plate	12 (11-13)
No. of rhinaria on	Ant.III	29 (20-43)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.22 (1.10-1.41)
	PT / Ant.VIb	0.68 (0.63-0.77)
	PT / Ant.III	0.14 (0.13-0.16)
	URS / 2HT	0.73 (0.67-0.80)
	URS / Ant.VIb	0.45 (0.35-0.53)
	SIPH / Body length	0.03 (0.03-0.04)
	SIPH / Ant.III	0.07 (0.06-0.09)
	SIPH / HFM	0.08 (0.07-0.09)
	SIPH / Cauda	0.56 (0.44-0.68)
	Setae on Ant.III / BDAnt.III	0.75 (0.50-1.00)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S12. Biometric data of *Euceraphis papyrifericola* Blackman from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	3.58 (3.04-4.11)
	Whole Antennae	4.66 (4.46-4.84)
	Ant.I	0.18 (0.17-0.19)
	Ant.II	0.12 (0.11-0.13)
	Ant.III	1.67 (1.61-1.72)
	Ant.IV	1.20 (1.13-1.29)
	Ant.V	0.96 (0.91-1.03)
	Ant.VIb	0.30 (0.28-0.35)
	PT	0.23 (0.21-0.24)
	URS	0.16 (0.14-0.18)
	HFM	1.67 (1.66-1.70)
	HTB	2.93 (2.80-3.05)
	2HT	0.22 (0.21-0.23)
	SIPH	0.15 (0.11-0.17)
	Cauda	0.22 (0.21-0.23)
	Longest setae on Ant.III	0.03 (0.03-0.04)
No. of setae on	Ant.I	10 (9-11)
	Ant.II	8 (7-8)
	Ant.III	51 (39-58)
	Ant.VIb	1
	URS (accessory setae)	10 (9-11)
	SIPH	0
	8th abdominal tergite	6 (5-8)
	Cauda knob	11 (10-14)
	Anal plate	10 (9-12)
No. of rhinaria on	Ant.III	19 (17-21)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.32 (1.16-1.59)
	PT / Ant.VIb	0.76 (0.69-0.86)
	PT / Ant.III	0.14 (0.13-0.14)
	URS / 2HT	0.74 (0.61-0.86)
	URS / Ant.VIb	0.54 (0.47-0.62)
	SIPH / Body length	0.04 (0.03-0.06)
	SIPH / Ant.III	0.09 (0.06-0.10)
	SIPH / HFM	0.09 (0.07-0.10)
	SIPH / Cauda	0.69 (0.52-0.81)
	Setae on Ant.III / BDAnt.III	0.49 (0.43-0.57)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S13. Biometric data of *Euceraphis punctipennis* Zetterstedt from Korea

	Body parts	Alate viviparous female (n=6)
Length (mm)	Body length	3.63 (3.44-3.77)
	Whole Antennae	4.43 (3.87-4.96)
	Ant.I	0.17 (0.15-0.19)
	Ant.II	0.12 (0.12-0.13)
	Ant.III	1.50 (1.27-1.69)
	Ant.IV	1.10 (0.97-1.22)
	Ant.V	0.98 (0.86-1.12)
	Ant.VIb	0.34 (0.30-0.37)
	PT	0.23 (0.21-0.24)
	URS	0.15 (0.14-0.16)
	HFM	1.53 (1.32-1.77)
	HTB	2.78 (2.38-3.11)
	2HT	0.22 (0.22-0.23)
	SIPH	0.12 (0.11-0.15)
	Cauda	0.19 (0.15-0.24)
	Longest setae on Ant.III	0.03 (0.03-0.04)
No. of setae on	Ant.I	10 (9-12)
	Ant.II	8 (7-9)
	Ant.III	45 (18-65)
	Ant.VIb	1
	URS (accessory setae)	10 (9-12)
	SIPH	0
	8th abdominal tergite	6 (5-7)
	Cauda knob	11 (10-12)
	Anal plate	12 (10-12)
No. of rhinaria on	Ant.III	19 (15-20)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.22 (1.13-1.32)
	PT / Ant.VIb	0.67 (0.62-0.72)
	PT / Ant.III	0.15 (0.14-0.17)
	URS / 2HT	0.65 (0.64-0.70)
	URS / Ant.VIb	0.43 (0.41-0.47)
	SIPH / Body length	0.03 (0.03-0.04)
	SIPH / Ant.III	0.08 (0.07-0.09)
	SIPH / HFM	0.08 (0.07-0.08)
	SIPH / Cauda	0.63 (0.58-0.73)
	Setae on Ant.III / BDAnt.III	0.52 (0.43-0.67)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S14. Biometric data of *Neobetulaphis pusila* Basu from Korea

	Body parts	Apterous viviparous female (n=10)
Length (mm)	Body length	1.98 (1.59-2.19)
	Whole Antennae	1.03 (0.95-1.11)
	Ant.I	0.08 (0.07-0.09)
	Ant.II	0.06 (0.05-0.08)
	Ant.III	0.31 (0.27-0.34)
	Ant.IV	0.18 (0.16-0.21)
	Ant.V	0.18 (0.17-0.20)
	Ant.VIb	0.12 (0.11-0.13)
	PT	0.10 (0.08-0.11)
	URS	0.11 (0.11-0.12)
	HFM	0.41 (0.33-0.46)
	HTB	0.70 (0.59-0.77)
	2HT	0.12 (0.12-0.13)
	SIPH	0.09 (0.08-0.11)
	Cauda	0.21 (0.20-0.22)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	6
	Ant.II	8
	Ant.III	4 (3-4)
	Ant.VIb	1
	URS (accessory setae)	3 (3-4)
	SIPH	0
	8th abdominal tergite	9 (9-10)
	Cauda knob	28 (22-34)
	Each lobe of anal plate	15 (10-17)
No. of rhinaria on	Ant.III	0
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.52 (0.47-0.62)
	PT / Ant.VIb	0.80 (0.67-0.92)
	PT / Ant.III	0.31 (0.26-0.37)
	URS / 2HT	0.92 (0.85-1.00)
	URS / Ant.VIb	0.94 (0.85-1.00)
	SIPH / Body length	0.05 (0.04-0.06)
	SIPH / Ant.III	0.30 (0.24-0.35)
	SIPH / HFM	0.23 (0.18-0.28)
	SIPH / Cauda	0.45 (0.36-0.52)
	Setae on Ant.III / BDAnt.III	0.33

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S15. Biometric data of *Symydobius* (*S.*) *minutus* Quednau & Shaposhnikov from Korea

	Body parts	Apterous viviparous female (n=9)	Alate viviparous female (n=3)
Length (mm)	Body length	2.78 (2.40-3.64)	3.60 (3.48-3.69)
	Whole Antennae	1.99 (1.80-2.27)	2.66 (2.20-2.84)
	Ant.I	0.12 (0.11-0.13)	0.14 (0.13-0.15)
	Ant.II	0.09 (0.08-0.11)	0.11 (0.10-0.12)
	Ant.III	0.74 (0.64-0.86)	1.04 (0.97-1.12)
	Ant.IV	0.37 (0.32-0.46)	0.51 (0.37-0.59)
	Ant.V	0.35 (0.30-0.39)	0.44 (0.34-0.51)
	Ant.VIb	0.19 (0.18-0.20)	0.20 (0.18-0.22)
	PT	0.13 (0.12-0.15)	0.12 (0.10-0.14)
	URS	0.14 (0.13-0.15)	0.14
	HFM	0.82 (0.69-1.06)	1.10 (1.03-1.14)
	HTB	1.53 (1.27-2.11)	2.07 (1.19-2.16)
	2HT	0.19 (0.17-0.21)	0.19 (0.18-0.21)
	SIPH	0.04 (0.02-0.06)	0.07 (0.06-0.07)
	Cauda	0.09 (0.07-0.10)	0.08 (0.06-0.09)
	Longest setae on Ant.III	0.08 (0.06-0.12)	0.10 (0.08-0.12)
No. of setae on	Ant.I	21 (19-22)	22 (18-25)
	Ant.II	15 (11-18)	14 (12-15)
	Ant.III	87 (71-95)	89 (83-97)
	Ant.VIb	8 (7-9)	8 (5-10)
	URS (accessory setae)	18 (16-20)	21 (18-23)
	SIPH	0	0
	8th abdominal tergite	8	11 (10-12)
	Cauda knob	27 (24-28)	24 (21-26)
	Anal plate	63 (58-68)	53 (49-56)
No. of rhinaria on	Ant.III	17 (12-23)	33 (31-37)
	Ant. IV	0	0
	Ant. V	1	1
Ratio (times)	Antennae / Body length	0.72 (0.62-0.81)	0.71 (0.63-0.77)
	PT / Ant.VIb	0.72 (0.60-0.83)	0.60 (0.56-0.64)
	PT / Ant.III	0.18 (0.14-0.23)	0.12 (0.10-0.13)
	URS / 2HT	0.76 (0.67-0.83)	0.73 (0.67-0.78)
	URS / Ant.VIb	0.75 (0.65-0.83)	0.69 (0.64-0.78)
	SIPH / Body length	0.01 (0.01-0.02)	0.02
	SIPH / Ant.III	0.05 (0.03-0.07)	0.06 (0.06-0.07)
	SIPH / HFM	0.05 (0.03-0.07)	0.06
	SIPH / Cauda	0.47 (0.20-0.67)	0.90 (0.67-1.17)
	Setae on Ant.III / BDAnt.III	1.38 (1.00-2.00)	1.34 (1.14-1.50)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S16. Biometric data of *Symydobius* (*Y.*) *kabae* (Matsumura) from Korea

	Body parts	Apterous viviparous female (n=20)	Alate viviparous female (n=14)
Length (mm)	Body length	2.57 (2.38-2.84)	3.46 (2.93-3.72)
	Whole Antennae	2.38 (2.25-2.59)	2.66 (2.41-2.88)
	Ant.I	0.14 (0.13-0.16)	0.15 (0.14-0.16)
	Ant.II	0.10 (0.08-0.11)	0.10 (0.09-0.12)
	Ant.III	0.92 (0.87-0.99)	1.00 (0.89-1.10)
	Ant.IV	0.50 (0.44-0.55)	0.59 (0.56-0.64)
	Ant.V	0.41 (0.36-0.49)	0.48 (0.41-0.53)
	Ant.VIb	0.19 (0.18-0.21)	0.20 (0.19-0.23)
	PT	0.12 (0.11-0.14)	0.13 (0.12-0.14)
	URS	0.14 (0.13-0.14)	0.14 (0.13-0.15)
	HFM	0.86 (0.81-0.97)	0.96 (0.89-1.04)
	HTB	1.39 (0.97-1.55)	1.74 (1.59-1.91)
	2HT	0.18 (0.16-0.19)	0.18 (0.18-0.19)
	SIPH	0.03 (0.03-0.04)	0.03 (0.02-0.03)
	Cauda	0.10 (0.09-0.12)	0.08 (0.07-0.09)
	Longest setae on Ant.III	0.08 (0.08-0.09)	0.07 (0.06-0.08)
No. of setae on	Ant.I	29 (26-33)	30 (27-35)
	Ant.II	14 (11-16)	13 (11-16)
	Ant.III	92 (84-101)	84 (70-99)
	Ant.VIb	12 (10-16)	12 (12-13)
	URS (accessory setae)	19 (16-21)	22 (18-25)
	SIPH	0	0
	8th abdominal tergite	19 (15-22)	18 (13-24)
	Cauda knob	32 (30-34)	17 (13-21)
	Anal plate	34 (32-36)	67 (59-74)
No. of rhinaria on	Ant.III	16 (10-22)	()
	Ant. IV	0	0
	Ant. V	1	1
Ratio (times)	Antennae / Body length	0.93 (0.88-0.99)	0.73 (0.65-0.78)
	PT / Ant.VIb	0.65 (0.52-0.78)	0.64 (0.57-0.74)
	PT / Ant.III	0.13 (0.11-0.15)	0.13 (0.12-0.14)
	URS / 2HT	0.77 (0.68-0.82)	0.78 (0.72-0.83)
	URS / Ant.VIb	0.72 (0.67-0.78)	0.71 (0.65-0.79)
	SIPH / Body length	0.01 (0.01-0.02)	0.01
	SIPH / Ant.III	0.04 (0.03-0.04)	0.03 (0.02-0.03)
	SIPH / HFM	0.04 (0.03-0.05)	0.03 (0.02-0.03)
	SIPH / Cauda	0.33 (0.25-0.44)	0.32 (0.22-0.38)
	Setae on Ant.III / BDAnt.III	1.67 (1.60-1.80)	1.34 (1.00-1.60)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S17. Biometric data of *Monaphis antennata* (Kaltenbach) from Korea

	Body parts	Alate viviparous female (n=9)
Length (mm)	Body length	3.63 (3.00-4.14)
	Whole Antennae	5.49 (5.18-5.73)
	Ant.I	0.18 (0.16-0.20)
	Ant.II	0.13 (0.11-0.15)
	Ant.III	1.31 (1.22-1.40)
	Ant.IV	0.94 (0.87-1.01)
	Ant.V	0.82 (0.65-0.93)
	Ant.VIb	0.21 (0.17-0.24)
	PT	1.91 (1.80-2.08)
	URS	0.17 (0.15-0.18)
	HFM	0.87 (0.81-0.94)
	HTB	1.70 (1.57-1.77)
	2HT	0.18 (0.17-0.19)
	SIPH	0.03 (0.02-0.04)
	Cauda	0.06 (0.06-0.07)
	Longest setae on Ant.III	0.02
No. of setae on	Ant.I	13 (8-17)
	Ant.II	10 (9-11)
	Ant.III	35 (27-42)
	Ant.VIb	4 (3-5)
	URS (accessory setae)	7 (6-8)
	SIPH	0
	8th abdominal tergite	13 (12-14)
	Cauda knob	9 (7-10)
	Each lobe of anal plate	16 (14-18)
No. of rhinaria on	Ant.III	50 (46-57)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.54 (1.31-1.87)
	PT / Ant.VIb	9.33 (8.18-10.59)
	PT / Ant.III	1.48 (1.29-1.70)
	URS / 2HT	0.94 (0.83-1.06)
	URS / Ant.VIb	0.82 (0.68-1.00)
	SIPH / Body length	0.01
	SIPH / Ant.III	0.03 (0.02-0.03)
	SIPH / HFM	0.04 (0.02-0.05)
	SIPH / Cauda	0.15 (0.13-0.17)
	Setae on Ant.III / BDAnt.III	0.25 (0.22-0.25)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S18. Biometric data of *Tuberculatus* (*A.*) *alienae* Lee, sp. nov. from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.99 (1.76-2.23)
	Whole Antennae	1.47 (1.28-1.56)
	Ant.I	0.08 (0.07-0.09)
	Ant.II	0.07 (0.06-0.08)
	Ant.III	0.44 (0.40-0.49)
	Ant.IV	0.27 (0.24-0.31)
	Ant.V	0.27 (0.25-0.29)
	Ant.VIb	0.16 (0.14-0.18)
	PT	0.17 (0.10-0.20)
	URS	0.13 (0.13-0.14)
	HFM	0.56 (0.42-0.87)
	HTB	1.00 (0.86-1.08)
	2HT	0.13 (0.12-0.14)
	SIPH	0.08 (0.07-0.09)
	Cauda	0.14 (0.12-0.17)
	Longest setae on Ant.III	0.10 (0.08-0.13)
No. of setae on	Ant.I	3 (3-4)
	Ant.II	3 (2-3)
	Ant.III	15 (14-17)
	Ant.VIb	2 (1-3)
	URS (accessory setae)	12 (10-14)
	SIPH	0
	8th abdominal tergite	11 (8-12)
	Cauda knob	20 (17-22)
	Each lobe of anal plate	18 (16-22)
No. of rhinaria on	Ant.III	5 (5-6)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.74 (0.70-0.84)
	PT / Ant.VIb	1.07 (0.71-1.27)
	PT / Ant.III	0.38 (0.25-0.47)
	URS / 2HT	1.03 (1.00-1.17)
	URS / Ant.VIb	0.86 (0.72-1.00)
	SIPH / Body length	0.04 (0.04-0.05)
	SIPH / Ant.III	0.19 (0.16-0.23)
	SIPH / HFM	0.15 (0.10-0.19)
	SIPH / Cauda	0.58 (0.50-0.75)
	Setae on Ant.III / BDAnt.III	3.77 (3.00-4.50)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S19. Biometric data of *Tuberculatus* (*A.*) *macrotuberculatus* (Essig & Kuwana) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.67 (2.37-2.93)
	Whole Antennae	1.65 (1.55-1.69)
	Ant.I	0.09 (0.09-0.10)
	Ant.II	0.08 (0.07-0.09)
	Ant.III	0.52 (0.48-0.56)
	Ant.IV	0.34 (0.33-0.37)
	Ant.V	0.31 (0.29-0.32)
	Ant.VIb	0.15 (0.14-0.16)
	PT	0.13 (0.12-0.15)
	URS	0.21 (0.20-0.22)
	HFM	0.69 (0.67-0.73)
	HTB	1.38 (1.31-1.48)
	2HT	0.14 (0.13-0.15)
	SIPH	0.10 (0.09-0.11)
	Cauda	0.15 (0.14-0.15)
	Longest setae on Ant.III	0.08 (0.08-0.09)
No. of setae on	Ant.I	4 (4-5)
	Ant.II	3 (2-3)
	Ant.III	20 (18-21)
	Ant.VIb	2 (2-3)
	URS (accessory setae)	14 (13-15)
	SIPH	0
	8th abdominal tergite	7 (6-8)
	Cauda knob	21 (19-23)
	Each lobe of anal plate	21 (21-22)
No. of rhinaria on	Ant.III	7 (7-9)
	Ant. IV	0 (0-1)
	Ant. V	1
Ratio (times)	Antennae / Body length	0.61 (0.58-0.65)
	PT / Ant.VIb	0.89 (0.81-1.00)
	PT / Ant.III	0.26 (0.23-0.29)
	URS / 2HT	1.48 (1.40-1.57)
	URS / Ant.VIb	1.40 (1.31-1.50)
	SIPH / Body length	0.04
	SIPH / Ant.III	0.19 (0.17-0.22)
	SIPH / HFM	0.14 (0.13-0.15)
	SIPH / Cauda	0.68 (0.64-0.73)
	Setae on Ant.III / BDAnt.III	2.80 (2.67-3.00)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S20. Biometric data of *Tuberculatus* (*A.*) *quercicola* Matsumura from Korea

	Body parts	Alate viviparous female (n=19)
Length (mm)	Body length	2.25 (2.10-2.35)
	Whole Antennae	1.40 (1.37-1.45)
	Ant.I	0.08 (0.07-0.09)
	Ant.II	0.07 (0.07-0.08)
	Ant.III	0.44 (0.40-0.46)
	Ant.IV	0.23 (0.20-0.27)
	Ant.V	0.26 (0.25-0.27)
	Ant.VIb	0.16 (0.15-0.17)
	PT	0.17 (0.16-0.17)
	URS	0.14 (0.13-0.15)
	HFM	0.54 (0.52-0.55)
	HTB	1.05 (1.00-1.09)
	2HT	0.15 (0.12-0.19)
	SIPH	0.08 (0.07-0.08)
	Cauda	0.15 (0.14-0.17)
	Longest setae on Ant.III	0.08 (0.07-0.09)
No. of setae on	Ant.I	4 (3-4)
	Ant.II	3 (2-4)
	Ant.III	11 (10-14)
	Ant.VIb	1 (1-2)
	URS (accessory setae)	10 (9-11)
	SIPH	0
	8th abdominal tergite	8 (6-10)
	Cauda knob	21 (18-22)
	Each lobe of anal plate	19 (17-21)
No. of rhinaria on	Ant.III	4
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.62 (0.61-0.65)
	PT / Ant.VIb	1.07 (1.00-1.13)
	PT / Ant.III	0.38 (0.36-0.40)
	URS / 2HT	1.00 (0.74-1.25)
	URS / Ant.VIb	0.91 (0.87-1.00)
	SIPH / Body length	0.03 (0.03-0.04)
	SIPH / Ant.III	0.18 (0.17-0.18)
	SIPH / HFM	0.15 (0.13-0.15)
	SIPH / Cauda	0.52 (0.47-0.57)
	Setae on Ant.III / BDAnt.III	2.50 (2.33-3.00)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S21. Biometric data of *Tuberculatus* (*A.*) *acutissimae* Lee, sp. nov. from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.19 (1.56-2.58)
	Whole Antennae	1.59 (1.10-1.95)
	Ant.I	0.08 (0.06-0.09)
	Ant.II	0.06 (0.05-0.07)
	Ant.III	0.48 (0.33-0.61)
	Ant.IV	0.28 (0.15-0.39)
	Ant.V	0.30 (0.21-0.35)
	Ant.VIb	0.17 (0.12-0.19)
	PT	0.22 (0.18-0.26)
	URS	0.12 (0.11-0.14)
	HFM	0.51 (0.36-0.61)
	HTB	1.04 (0.71-1.31)
	2HT	0.12 (0.09-0.14)
	SIPH	0.12 (0.10-0.13)
	Cauda	0.15 (0.12-0.16)
	Longest setae on Ant.III	0.06 (0.04-0.07)
No. of setae on	Ant.I	3
	Ant.II	3
	Ant.III	8 (5-13)
	Ant.VIb	1
	URS (accessory setae)	8 (7-9)
	SIPH	0
	8th abdominal tergite	6 (4-8)
	Cauda knob	16 (14-17)
	Each lobe of anal plate	15 (13-17)
No. of rhinaria on	Ant.III	6 (3-8)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.72 (0.66-0.79)
	PT / Ant.VIb	1.32 (1.11-1.50)
	PT / Ant.III	0.47 (0.38-0.55)
	URS / 2HT	1.03 (0.92-1.22)
	URS / Ant.VIb	0.74 (0.63-0.92)
	SIPH / Body length	0.06 (0.05-0.08)
	SIPH / Ant.III	0.27 (0.21-0.36)
	SIPH / HFM	0.25 (0.21-0.33)
	SIPH / Cauda	0.83 (0.71-1.00)
	Setae on Ant.III / BDAnt.III	1.83 (1.33-2.33)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S22. Biometric data of *Tuberculatus* (*A.*) *indicus* Gosh from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.94 (2.45-3.21)
	Whole Antennae	1.90 (1.75-2.00)
	Ant.I	0.10 (0.09-0.10)
	Ant.II	0.08 (0.07-0.09)
	Ant.III	0.57 (0.51-0.59)
	Ant.IV	0.38 (0.33-0.41)
	Ant.V	0.36 (0.32-0.40)
	Ant.VIb	0.20 (0.19-0.21)
	PT	0.22 (0.21-0.24)
	URS	0.12 (0.11-0.13)
	HFM	0.68 (0.59-0.72)
	HTB	1.10 (0.69-1.31)
	2HT	0.13 (0.12-0.15)
	SIPH	0.14 (0.13-0.15)
	Cauda	0.18 (0.17-0.19)
	Longest setae on Ant.III	0.05
No. of setae on	Ant.I	3
	Ant.II	3
	Ant.III	9 (9-10)
	Ant.VIb	1
	URS (accessory setae)	8 (7-8)
	SIPH	0
	8th abdominal tergite	6 (6-7)
	Cauda knob	15 (13-17)
	Each lobe of anal plate	18 (14-21)
No. of rhinaria on	Ant.III	6 (4-8)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.65 (0.61-0.71)
	PT / Ant.VIb	1.12 (1.05-1.26)
	PT / Ant.III	0.40 (0.36-0.47)
	URS / 2HT	0.93 (0.80-1.00)
	URS / Ant.VIb	0.60 (0.57-0.63)
	SIPH / Body length	0.05 (0.04-0.05)
	SIPH / Ant.III	0.24 (0.23-0.25)
	SIPH / HFM	0.20 (0.18-0.22)
	SIPH / Cauda	0.75 (0.68-0.82)
	Setae on Ant.III / BDAnt.III	1.19 (1.00-1.25)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S23. Biometric data of *Tuberculatus* (*A*.) *japonicus* Higuchi from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.63 (2.40-2.90)
	Whole Antennae	1.63 (1.46-1.75)
	Ant.I	0.08
	Ant.II	0.07 (0.06-0.07)
	Ant.III	0.53 (0.47-0.56)
	Ant.IV	0.31 (0.26-0.35)
	Ant.V	0.26 (0.24-0.28)
	Ant.VIb	0.19 (0.16-0.21)
	PT	0.21 (0.19-0.25)
	URS	0.17 (0.16-0.18)
	HFM	0.57 (0.51-0.63)
	HTB	1.20 (1.02-1.32)
	2HT	0.14 (0.13-0.14)
	SIPH	0.13 (0.11-0.14)
	Cauda	0.15 (0.13-0.17)
	Longest setae on Ant.III	0.04 (0.03-0.06)
No. of setae on	Ant.I	3 (2-3)
	Ant.II	2 (2-3)
	Ant.III	6 4-8()
	Ant.VIb	8 (4-5)
	URS (accessory setae)	6 (6-7)
	SIPH	0
	8th abdominal tergite	4-5
	Cauda knob	12 (9-15)
	Each lobe of anal plate	14 (12-17)
No. of rhinaria on	Ant.III	7 (6-9)
	Ant. IV	0 (0-2)
	Ant. V	1
Ratio (times)	Antennae / Body length	0.62 (0.60-0.68)
	PT / Ant.VIb	1.13 (1.05-1.19)
	PT / Ant.III	0.40 (0.36-0.51)
	URS / 2HT	1.24 (1.21-1.29)
	URS / Ant.VIb	0.91 (0.76-1.00)
	SIPH / Body length	0.05 (0.04-0.05)
	SIPH / Ant.III	0.24 (0.21-0.27)
	SIPH / HFM	0.22 (0.21-0.25)
	SIPH / Cauda	0.87 (0.76-0.93)
	Setae on Ant.III / BDAnt.III	1.47 (1.00-2.00)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S24. Biometric data of *Tuberculatus* (*A*.) *orientalis* Richards from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.06 (1.77-2.30)
	Whole Antennae	1.78 (1.65-1.91)
	Ant.I	0.11 (0.09-0.13)
	Ant.II	0.07 (0.06-0.07)
	Ant.III	0.54 (0.48-0.62)
	Ant.IV	0.30 (0.26-0.32)
	Ant.V	0.30 (0.27-0.32)
	Ant.VIb	0.15 (0.14-0.16)
	PT	0.31 (0.30-0.33)
	URS	0.11 (0.10-0.12)
	HFM	0.65 (0.58-0.73)
	HTB	1.24 (1.07-1.37)
	2HT	0.12 (0.10-0.14)
	SIPH	0.12 (0.09-0.14)
	Cauda	0.14 (0.12-0.16)
	Longest setae on Ant.III	0.06 (0.04-0.09)
No. of setae on	Ant.I	7 (5-8)
	Ant.II	4 (2-5)
	Ant.III	14 (12-15)
	Ant.VIb	1
	URS (accessory setae)	9 (8-11)
	SIPH	0
	8th abdominal tergite	5 (4-6)
	Cauda knob	13 (11-16)
	Each lobe of anal plate	14 (13-16)
No. of rhinaria on	Ant.III	7 (5-8)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.87 (0.80-0.98)
	PT / Ant.VIb	2.15 (1.88-2.36)
	PT / Ant.III	0.58 (0.48-0.64)
	URS / 2HT	0.98 (0.71-1.20)
	URS / Ant.VIb	0.77 (0.67-0.86)
	SIPH / Body length	0.06 (0.05-0.07)
	SIPH / Ant.III	0.23 (0.19-0.25)
	SIPH / HFM	0.19 (0.16-0.21)
	SIPH / Cauda	0.89 (0.73-1.00)
	Setae on Ant.III / BDAnt.III	2.17 (1.33-3.00)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S25. Biometric data of *Tuberculatus* (*A.*) *stigmatus* (Matsumura) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.26 (1.28-2.93)
	Whole Antennae	1.87 (1.65-2.27)
	Ant.I	0.11 (0.10-0.16)
	Ant.II	0.07 (0.03-0.08)
	Ant.III	0.54 (0.45-0.69)
	Ant.IV	0.34 (0.28-0.45)
	Ant.V	0.32 (0.28-0.40)
	Ant.VIb	0.16 (0.14-0.21)
	PT	0.32 (0.29-0.34)
	URS	0.11 (0.11-0.12)
	HFM	0.73 (0.60-0.92)
	HTB	1.46 (1.24-1.80)
	2HT	0.12 (0.10-0.15)
	SIPH	0.09 (0.06-0.17)
	Cauda	0.16 (0.14-0.18)
	Longest setae on Ant.III	0.07 (0.05-0.09)
No. of setae on	Ant.I	3 (3-4)
	Ant.II	3
	Ant.III	7 (6-9)
	Ant.VIb	5 (4-7)
	URS (accessory setae)	8 (8-9)
	SIPH	0
	8th abdominal tergite	10 (8-12)
	Cauda knob	16 (14-17)
	Each lobe of anal plate	15 (13-15)
No. of rhinaria on	Ant.III	6 (4-13)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.86 (0.71-1.36)
	PT / Ant.VIb	1.98 (1.62-2.21)
	PT / Ant.III	0.59 (0.49-0.69)
	URS / 2HT	0.97 (0.73-1.20)
	URS / Ant.VIb	0.72 (0.52-0.86)
	SIPH / Body length	0.04 (0.03-0.06)
	SIPH / Ant.III	0.17 (0.11-0.25)
	SIPH / HFM	0.12 (0.09-0.18)
	SIPH / Cauda	0.65 (0.40-1.29)
	Setae on Ant.III / BDAnt.III	2.05 (1.25-3.00)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S26. Biometric data of *Tuberculatus* (*N.*) *hirta* Lee, sp. nov. from Korea

	Body parts	Alate viviparous female (n=16)
Length (mm)	Body length	1.95 (1.79-2.19)
	Whole Antennae	1.20 (1.18-1.24)
	Ant.I	0.06
	Ant.II	0.07 (0.06-0.07)
	Ant.III	0.46 (0.43-0.49)
	Ant.IV	0.24 (0.23-0.25)
	Ant.V	0.19 (0.18-0.19)
	Ant.VIb	0.10 (0.10-0.11)
	PT	0.09 (0.07-0.10)
	URS	0.12 (0.11-0.13)
	HFM	0.44 (0.41-0.47)
	HTB	0.81 (0.78-0.85)
	2HT	0.11 (0.11-0.12)
	SIPH	0.09 (0.09-0.11)
	Cauda	0.09 (0.08-0.11)
	Longest setae on Ant.III	0.08 (0.07-0.08)
No. of setae on	Ant.I	3
	Ant.II	2
	Ant.III	7 (6-9)
	Ant.VIb	1
	URS (accessory setae)	11 (10-11)
	SIPH	0
	8th abdominal tergite	7 (5-10)
	Cauda knob	12 (10-13)
	Each lobe of anal plate	13 (10-15)
No. of rhinaria on	Ant.III	7 (6-8)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.62 (0.57-0.67)
	PT / Ant.VIb	0.83 (0.70-1.00)
	PT / Ant.III	0.18 (0.15-0.22)
	URS / 2HT	1.04 (1.00-1.09)
	URS / Ant.VIb	1.15 (1.09-1.30)
	SIPH / Body length	0.05 (0.04-0.05)
	SIPH / Ant.III	0.20 (0.18-0.23)
	SIPH / HFM	0.21 (0.19-0.23)
	SIPH / Cauda	1.04 (0.91-1.13)
	Setae on Ant.III / BDAnt.III	2.58 (2.33-2.67)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S27. Biometric data of *Tuberculatus* (*N.*) *kuricola* Matsumura from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.74 (1.40-2.08)
	Whole Antennae	1.05 (0.89-1.19)
	Ant.I	0.06 (0.05-0.07)
	Ant.II	0.06 (0.05-0.07)
	Ant.III	0.38 (0.30-0.46)
	Ant.IV	0.20 (0.15-0.25)
	Ant.V	0.16 (0.14-0.18)
	Ant.VIb	0.10 (0.09-0.11)
	PT	0.09 (0.07-0.10)
	URS	0.11 (0.10-0.13)
	HFM	0.38 (0.31-0.46)
	HTB	0.69 (0.56-0.84)
	2HT	0.10 (0.09-0.11)
	SIPH	0.09 (0.08-0.11)
	Cauda	0.10 (0.08-0.12)
	Longest setae on Ant.III	0.08 (0.06-0.09)
No. of setae on	Ant.I	3
	Ant.II	2 (2-3)
	Ant.III	7 (6-9)
	Ant.VIb	1
	URS (accessory setae)	10 (9-11)
	SIPH	0
	8th abdominal tergite	7 (6-8)
	Cauda knob	13 (11-14)
	Each lobe of anal plate	12 (9-15)
No. of rhinaria on	Ant.III	6 (5-9)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.60 (0.56-0.66)
	PT / Ant.VIb	0.93 (0.64-1.11)
	PT / Ant.III	0.24 (0.17-0.33)
	URS / 2HT	1.12 (1.00-1.20)
	URS / Ant.VIb	1.12 (1.09-1.18)
	SIPH / Body length	0.05 (0.05-0.06)
	SIPH / Ant.III	0.25 (0.21-0.30)
	SIPH / HFM	0.25 (0.20-0.29)
	SIPH / Cauda	0.95 (0.75-1.13)
	Setae on Ant.III / BDAnt.III	3.83 (3.00-4.50)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S28. Biometric data of *Tuberculatus* (*O.*) *alba* Lee, sp. nov. from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.66 (2.52-2.74)
	Whole Antennae	2.80 (2.71-2.90)
	Ant.I	0.10 (0.10-0.11)
	Ant.II	0.07 (0.07-0.08)
	Ant.III	0.86 (0.81-0.93)
	Ant.IV	0.57 (0.52-0.62)
	Ant.V	0.51 (0.48-0.54)
	Ant.VIb	0.30 (0.28-0.32)
	PT	0.38 (0.36-0.39)
	URS	0.13 (0.12-0.13)
	HFM	0.78 (0.75-0.83)
	HTB	1.46 (1.41-1.54)
	2HT	0.13 (0.12-0.14)
	SIPH	0.13 (0.13-0.14)
	Cauda	0.17 (0.16-0.17)
	Longest setae on Ant.III	0.02 (0.02-0.03)
No. of setae on	Ant.I	3 (2-4)
	Ant.II	3 (2-3)
	Ant.III	13 (10-15)
	Ant.VIb	1
	URS (accessory setae)	8 (8-9)
	SIPH	0
	8th abdominal tergite	8 (7-9)
	Cauda knob	14 (13-15)
	Each lobe of anal plate	15 (13-16)
No. of rhinaria on	Ant.III	7 (5-8)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.05 (1.01-1.15)
	PT / Ant.VIb	1.28 (1.22-1.36)
	PT / Ant.III	0.44 (0.39-0.47)
	URS / 2HT	0.99 (0.93-1.00)
	URS / Ant.VIb	0.42 (0.38-0.46)
	SIPH / Body length	0.05 (0.05-0.06)
	SIPH / Ant.III	0.16 (0.15-0.16)
	SIPH / HFM	0.17 (0.17-0.18)
	SIPH / Cauda	0.80 (0.76-0.82)
	Setae on Ant.III / BDAnt.III	0.72 (0.50-1.00)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S29. Biometric data of *Tuberculatus* (*O.*) *capitatus* (Essig & Kuwana) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.26 (1.67-2.87)
	Whole Antennae	2.04 (1.79-2.28)
	Ant.I	0.09 (0.08-0.10)
	Ant.II	0.07 (0.06-0.07)
	Ant.III	0.66 (0.58-0.72)
	Ant.IV	0.38 (0.30-0.44)
	Ant.V	0.35 (0.30-0.40)
	Ant.VIb	0.20 (0.17-0.21)
	PT	0.30 (0.24-0.35)
	URS	0.12 (0.11-0.14)
	HFM	0.57 (0.46-0.64)
	HTB	1.14 (0.89-1.27)
	2HT	0.13 (0.12-0.14)
	SIPH	0.14 (0.13-0.15)
	Cauda	0.16 (0.12-0.20)
	Longest setae on Ant.III	0.05 (0.04-0.06)
No. of setae on	Ant.I	3 (2-3)
	Ant.II	3 (2-3)
	Ant.III	11 (8-14)
	Ant.VIb	1 (1-2)
	URS (accessory setae)	8 (7-9)
	SIPH	0
	8th abdominal tergite	4 (3-5)
	Cauda knob	17 (15-22)
	Each lobe of anal plate	16 (13-21)
No. of rhinaria on	Ant.III	4 (3-4)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.93 (0.67-1.07)
	PT / Ant.VIb	1.53 (1.14-1.79)
	PT / Ant.III	0.46 (0.41-0.49)
	URS / 2HT	0.95 (0.92-1.00)
	URS / Ant.VIb	0.61 (0.52-0.71)
	SIPH / Body length	0.07 (0.05-0.08)
	SIPH / Ant.III	0.22 (0.19-0.26)
	SIPH / HFM	0.26 (0.23-0.28)
	SIPH / Cauda	0.89 (0.75-1.08)
	Setae on Ant.III / BDAnt.III	1.63 (1.33-2.00)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S30. Biometric data of *Tuberculatus* (*O.*) *fangi* (Tseng & Tao) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.23 (1.87-2.50)
	Whole Antennae	1.80 (1.40-2.44)
	Ant.I	0.09 (0.08-0.10)
	Ant.II	0.07 (0.06-0.08)
	Ant.III	0.61 (0.43-0.97)
	Ant.IV	0.31 (0.23-0.43)
	Ant.V	0.29 (0.22-0.36)
	Ant.VIb	0.17 (0.14-0.20)
	PT	0.28 (0.24-0.34)
	URS	0.12 (0.12-0.13)
	HFM	0.54 (0.43-0.67)
	HTB	1.06 (0.89-1.28)
	2HT	0.12 (0.12-0.13)
	SIPH	0.13 (0.12-0.15)
	Cauda	0.16 (0.15-0.18)
	Longest setae on Ant.III	0.07 (0.05-0.10)
No. of setae on	Ant.I	3
	Ant.II	3 (3-4)
	Ant.III	13 (11-16)
	Ant.VIb	2
	URS (accessory setae)	13 (10-15)
	SIPH	0
	8th abdominal tergite	5 (5-6)
	Cauda knob	17 (16-19)
	Each lobe of anal plate	17 (15-19)
No. of rhinaria on	Ant.III	3 (2-4)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.80 (0.71-0.98)
	PT / Ant.VIb	1.66 (1.50-1.71)
	PT / Ant.III	0.48 (0.31-0.56)
	URS / 2HT	1.00 (0.92-1.08)
	URS / Ant.VIb	0.74 (0.60-0.86)
	SIPH / Body length	0.60 (0.05-0.06)
	SIPH / Ant.III	0.23 (0.14-0.28)
	SIPH / HFM	0.24 (0.21-0.28)
	SIPH / Cauda	0.79 (0.71-0.88)
	Setae on Ant.III / BDAnt.III	2.47 (1.67-3.33)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S31. Biometric data of *Tuberculatus* (*O.*) *fuscotuberculatus* Zhang from Korea

	Body parts	Oviparous female (n=2)
Length (mm)	Body length	3.20 (3.02-3.38)
	Whole Antennae	1.69 (1.63-1.75)
	Ant.I	0.11 (0.10-0.11)
	Ant.II	0.07
	Ant.III	0.46 (0.41-.051)
	Ant.IV	0.30 (0.29-0.30)
	Ant.V	0.30 (0.29-0.30)
	Ant.VIb	0.21 (0.19-0.22)
	PT	0.26 (0.25-0.27)
	URS	0.11
	HFM	0.63 (0.60-0.65)
	HTB	1.11 (1.07-1.14)
	2HT	0.16 (0.14-0.18)
	SIPH	0.12 (0.10-0.13)
	Longest setae on Ant.III	0.03
No. of setae on	Ant.I	3
	Ant.II	2
	Ant.III	11 (8-14)
	Ant.VIb	1
	URS (accessory setae)	4
	SIPH	0
	8th abdominal tergite	6 (5-6)
No. of rhinaria on	Ant.III	0
	Ant. IV	0
	Ant. V	1
No. of pseudosensoria on	HTB	166 (160-171)
Ratio (times)	Antennae / Body length	0.53 (0.52-0.54)
	PT / Ant.VIb	1.28 (1.14-1.42)
	PT / Ant.III	0.57 (0.53-0.61)
	URS / 2HT	0.70 (0.61-0.79)
	URS / Ant.VIb	0.54 (0.50-0.58)
	SIPH / Body length	0.04 (0.03-0.04)
	SIPH / Ant.III	0.25 (0.24-0.25)
	SIPH / HFM	0.18 (0.17-0.20)
	Setae on Ant.III / BDAnt.III	0.75

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S32. Biometric data of *Tuberculatus (O.) higuchii* Hille Ris Lambers from Korea

	Body parts	Alate viviparous female (n=2)
Length (mm)	Body length	1.62 (1.16-2.08)
	Whole Antennae	-
	Ant.I	0.07 (0.06-0.08)
	Ant.II	0.05 (0.04-0.06)
	Ant.III	0.51 (0.41-0.60)
	Ant.IV	0.35 (0.28-0.42)
	Ant.V	0.38
	Ant.VIb	0.23
	PT	-
	URS	0.10
	HFM	0.45 (0.36-0.54)
	HTB	0.85 (0.67-1.03)
	2HT	0.12 (0.11-0.12)
	SIPH	0.12 (0.11-0.12)
	Cauda	0.14
	Longest setae on Ant.III	0.02 (0.01-0.02)
No. of setae on	Ant.I	3 (2-3)
	Ant.II	3 (2-3)
	Ant.III	10 (9-10)
	Ant.VIb	1
	URS (accessory setae)	7 (6-7)
	SIPH	0
	8th abdominal tergite	4
	Cauda knob	14 (13-15)
	Each lobe of anal plate	14 (12-15)
No. of rhinaria on	Ant.III	5
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	-
	PT / Ant.VIb	-
	PT / Ant.III	-
	URS / 2HT	0.87 (0.83-0.91)
	URS / Ant.VIb	0.43
	SIPH / Body length	0.08 (0.05-0.10)
	SIPH / Ant.III	0.24 (0.18-0.29)
	SIPH / HFM	0.27 (0.20-0.33)
	SIPH / Cauda	0.82 (0.79-0.86)
	Setae on Ant.III / BDAnt.III	0.50 (0.33-0.67)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S33. Biometric data of *Tuberculatus (O.) lambersi* Lee, sp. nov. from Korea

	Body parts	Alate viviparous female (n=7)
Length (mm)	Body length	2.64 (2.45-2.76)
	Whole Antennae	2.53 (2.43-2.67)
	Ant.I	0.09 (0.08-0.10)
	Ant.II	0.07 (0.06-0.07)
	Ant.III	0.79 (0.75-0.85)
	Ant.IV	0.51 (0.50-0.55)
	Ant.V	0.46 (0.43-0.49)
	Ant.VIb	0.29 (0.26-0.31)
	PT	0.32 (0.30-0.36)
	URS	0.11
	HFM	0.71 (0.68-0.76)
	HTB	1.40 (1.33-1.50)
	2HT	0.14 (0.13-0.15)
	SIPH	0.13 (0.12-0.14)
	Cauda	0.15 (0.14-0.16)
	Longest setae on Ant.III	0.02
No. of setae on	Ant.I	3
	Ant.II	2 (2-3)
	Ant.III	13 (12-14)
	Ant.VIb	1
	URS (accessory setae)	7 (6-7)
	SIPH	0
	8th abdominal tergite	9 (8-10)
	Cauda knob	14 (13-16)
	Each lobe of anal plate	17 (14-18)
No. of rhinaria on	Ant.III	6 (5-6)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.96 (0.90-1.00)
	PT / Ant.VIb	1.12 (1.00-1.17)
	PT / Ant.III	0.41 (0.38-0.46)
	URS / 2HT	0.79 (0.73-0.85)
	URS / Ant.VIb	0.39 (0.35-0.42)
	SIPH / Body length	0.05 (0.04-0.05)
	SIPH / Ant.III	0.16 (0.15-0.19)
	SIPH / HFM	0.18 (0.16-0.20)
	SIPH / Cauda	0.86 (0.75-1.00)
	Setae on Ant.III / BDAnt.III	0.50

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S34. Biometric data of *Tuberculatus* (*O.*) *paiki* Hille Ris Lambers from Korea

	Body parts	Alate viviparous female (n=1)
Length (mm)	Body length	2.06
	Whole Antennae	2.21
	Ant.I	0.09
	Ant.II	0.07
	Ant.III	0.71
	Ant.IV	0.40
	Ant.V	0.39
	Ant.VIb	0.22
	PT	0.33
	URS	0.14
	HFM	0.58
	HTB	1.25
	2HT	0.11
	SIPH	0.11
	Cauda	0.13
	Longest setae on Ant.III	0.04
No. of setae on	Ant.I	3
	Ant.II	3
	Ant.III	13
	Ant.VIb	1
	URS (accessory setae)	8
	SIPH	0
	8th abdominal tergite	7
	Cauda knob	15
	Each lobe of anal plate	13
No. of rhinaria on	Ant.III	3
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.07
	PT / Ant.VIb	1.50
	PT / Ant.III	0.46
	URS / 2HT	1.27
	URS / Ant.VIb	0.64
	SIPH / Body length	0.05
	SIPH / Ant.III	0.15
	SIPH / HFM	0.19
	SIPH / Cauda	0.85
	Setae on Ant.III / BDAnt.III	1.33

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S35. Biometric data of *Tuberculatus* (*O.*) *paranaracola* Hille Ris Lambers from Korea

	Body parts	Alate viviparous female (n=9)
Length (mm)	Body length	2.14 (1.82-2.44)
	Whole Antennae	1.89 (1.66-2.03)
	Ant.I	0.07 (0.06-0.08)
	Ant.II	0.07 (0.06-0.08)
	Ant.III	0.55 (0.48-0.60)
	Ant.IV	0.34 (0.27-0.41)
	Ant.V	0.31 (0.26-0.35)
	Ant.VIb	0.20 (0.17-0.21)
	PT	0.36 (0.33-0.39)
	URS	0.09 (0.08-0.11)
	HFM	0.52 (0.43-0.60)
	HTB	1.06 (0.90-1.25)
	2HT	0.12 (0.11-0.14)
	SIPH	0.10 (0.09-0.12)
	Cauda	0.11 (0.09-0.13)
	Longest setae on Ant.III	0.02
No. of setae on	Ant.I	3
	Ant.II	2 (2-3)
	Ant.III	7 (6-9)
	Ant.VIb	1
	URS (accessory setae)	6 (5-7)
	SIPH	0
	8th abdominal tergite	5 (4-6)
	Cauda knob	12 (11-13)
	Each lobe of anal plate	11 (9-14)
No. of rhinaria on	Ant.III	7 (6-9)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.89 (0.83-0.93)
	PT / Ant.VIb	1.85 (1.57-1.95)
	PT / Ant.III	0.66 (0.58-0.74)
	URS / 2HT	0.77 (0.67-0.82)
	URS / Ant.VIb	0.48 (0.40-0.53)
	SIPH / Body length	0.05 (0.04-0.05)
	SIPH / Ant.III	0.19 (0.15-0.21)
	SIPH / HFM	0.20 (0.17-0.23)
	SIPH / Cauda	0.92 (0.82-1.11)
	Setae on Ant.III / BDAnt.III	0.75 (0.67-1.00)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S36. Biometric data of *Tuberculatus* (*O.*) *querciformosanus* (Takahashi) from Korea

	Body parts	Alate viviparous female (n=4)
Length (mm)	Body length	2.29 (1.69-2.64)
	Whole Antennae	1.94 (1.71-2.21)
	Ant.I	0.08 (0.07-0.10)
	Ant.II	0.07 (0.06-0.07)
	Ant.III	0.54 (0.43-0.62)
	Ant.IV	0.38 (0.28-0.46)
	Ant.V	0.34 (0.31-0.38)
	Ant.VIb	0.18 (0.16-0.20)
	PT	0.36 (0.32-0.39)
	URS	0.17 (0.16-0.18)
	HFM	0.56 (0.44-0.62)
	HTB	1.26 (1.02-1.39)
	2HT	0.13 (0.12-0.15)
	SIPH	0.11 (0.10-0.12)
	Cauda	0.16 (0.15-0.18)
	Longest setae on Ant.III	0.04 (0.04-0.05)
No. of setae on	Ant.I	3 (2-3)
	Ant.II	3
	Ant.III	3
	Ant.VIb	7 (6-9)
	URS (accessory setae)	8 (7-10)
	SIPH	0
	8th abdominal tergite	4 (3-4)
	Cauda knob	18 (15-21)
	Each lobe of anal plate	14 (11-18)
No. of rhinaria on	Ant.III	4 (3-4)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.90 (0.72-1.01)
	PT / Ant.VIb	2.06 (1.90-2.29)
	PT / Ant.III	0.69 (0.56-0.91)
	URS / 2HT	1.31 (1.20-1.42)
	URS / Ant.VIb	0.99 (0.90-1.13)
	SIPH / Body length	0.05 (0.04-0.07)
	SIPH / Ant.III	0.21 (0.18-0.26)
	SIPH / HFM	0.20 (0.18-0.26)
	SIPH / Cauda	0.68 (0.63-0.73)
	Setae on Ant.III / BDAnt.III	1.33 (1.00-1.67)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S37. Biometric data of *Tuberculatus* (*O.*) *richardsi* Lee, sp. nov. from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.31 (1.82-2.71)
	Whole Antennae	2.21 (1.68-2.83)
	Ant.I	0.09 (0.07-0.11)
	Ant.II	0.06 (0.05-0.07)
	Ant.III	0.66 (0.49-0.87)
	Ant.IV	0.42 (0.26-0.55)
	Ant.V	0.42 (0.29-0.58)
	Ant.VIb	0.24 (0.18-0.31)
	PT	0.33 (0.28-0.37)
	URS	0.10 (0.08-0.12)
	HFM	0.60 (0.44-0.76)
	HTB	1.17 (0.88-1.55)
	2HT	0.12 (0.10-0.14)
	SIPH	0.10 (0.05-0.16)
	Cauda	0.13 (0.10-0.15)
	Longest setae on Ant.III	0.02 (0.01-0.02)
No. of setae on	Ant.I	3 (2-4)
	Ant.II	2 (2-3)
	Ant.III	11 (7-16)
	Ant.VIb	1
	URS (accessory setae)	7 (7-8)
	SIPH	0
	8th abdominal tergite	4 (4-7)
	Cauda knob	13 (12-14)
	Each lobe of anal plate	14 (12-15)
No. of rhinaria on	Ant.III	6 (4-8)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.95 (0.84-1.04)
	PT / Ant.VIb	1.39 (1.12-1.78)
	PT / Ant.III	0.52 (0.41-0.63)
	URS / 2HT	0.85 (0.79-1.00)
	URS / Ant.VIb	0.41 (0.35-0.44)
	SIPH / Body length	0.04 (0.03-0.06)
	SIPH / Ant.III	0.15 (0.10-0.19)
	SIPH / HFM	0.16 (0.11-0.21)
	SIPH / Cauda	0.75 (0.50-1.07)
	Setae on Ant.III / BDAnt.III	0.50 (0.33-0.67)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S38. Biometric data of *Tuberculatus* (*O.*) *silvae* Lee, sp. nov. from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.31 (1.98-2.94)
	Whole Antennae	2.45 (2.33-2.53)
	Ant.I	0.09 (0.08-0.10)
	Ant.II	0.07 (0.06-0.07)
	Ant.III	0.73 (0.66-0.80)
	Ant.IV	0.45 (0.40-0.53)
	Ant.V	0.46 (0.42-0.48)
	Ant.VIb	0.28 (0.26-0.30)
	PT	0.37 (0.30-0.43)
	URS	0.11 (0.11-0.12)
	HFM	0.63 (0.54-0.78)
	HTB	1.23 (1.11-1.38)
	2HT	0.12 (0.11-0.14)
	SIPH	0.11 (0.10-0.14)
	Cauda	0.13 (0.12-0.15)
	Longest setae on Ant.III	0.03 (0.02-0.03)
No. of setae on	Ant.I	3 (2-4)
	Ant.II	2 (2-3)
	Ant.III	12 (11-13)
	Ant.VIb	1
	URS (accessory setae)	8 (7-8)
	SIPH	0
	8th abdominal tergite	6 (5-8)
	Cauda knob	13 (9-15)
	Each lobe of anal plate	13 (11-15)
No. of rhinaria on	Ant.III	6 (5-7)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.08 (0.85-1.23)
	PT / Ant.VIb	1.31 (1.15-1.48)
	PT / Ant.III	0.51 (0.38-0.65)
	URS / 2HT	0.92 (0.79-1.00)
	URS / Ant.VIb	0.40 (0.37-0.42)
	SIPH / Body length	0.05
	SIPH / Ant.III	0.16 (0.14-0.18)
	SIPH / HFM	0.18 (0.17-0.20)
	SIPH / Cauda	0.85 (0.79-0.93)
	Setae on Ant.III / BDAnt.III	0.87 (0.67-1.00)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S39. Biometric data of *Tuberculatus* (O.) *yaoi* Lee, sp. nov. from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.20 (1.75-2.51)
	Whole Antennae	2.01 (1.52-2.38)
	Ant.I	0.08 (0.06-0.10)
	Ant.II	0.06 (0.05-0.07)
	Ant.III	0.58 (0.43-0.71)
	Ant.IV	0.38 (0.28-0.47)
	Ant.V	0.36 (0.23-0.44)
	Ant.VIb	0.22 (0.16-0.28)
	PT	0.32 (0.28-0.36)
	URS	0.09 (0.08-0.12)
	HFM	0.56 (0.41-0.64)
	HTB	1.09 (0.82-1.24)
	2HT	0.11 (0.10-0.13)
	SIPH	0.09 (0.07-0.10)
	Cauda	0.12 (0.09-0.15)
	Longest setae on Ant.III	0.02 (0.01-0.02)
No. of setae on	Ant.I	3
	Ant.II	2 (2-3)
	Ant.III	11 (8-13)
	Ant.VIb	1
	URS (accessory setae)	7 (6-9)
	SIPH	0
	8th abdominal tergite	7 (5-9)
	Cauda knob	15 (13-16)
	Each lobe of anal plate	14 (10-17)
No. of rhinaria on	Ant.III	4 (3-7)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.91 (0.82-0.97)
	PT / Ant.VIb	1.51 (1.18-1.94)
	PT / Ant.III	0.57 (0.46-0.72)
	URS / 2HT	0.81 (0.73-0.92)
	URS / Ant.VIb	0.43 (0.36-0.50)
	SIPH / Body length	0.04 (0.04-0.05)
	SIPH / Ant.III	0.16 (0.13-0.21)
	SIPH / HFM	0.17 (0.14-0.22)
	SIPH / Cauda	0.76 (0.64-1.00)
	Setae on Ant.III / BDAnt.III	0.57 (0.33-0.67)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S40. Biometric data of *Tuberculatus* (*O.*) *yokoyamai* (Takahashi) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.18 (1.77-2.50)
	Whole Antennae	2.07 (1.92-2.28)
	Ant.I	0.09 (0.07-0.11)
	Ant.II	0.06 (0.05-0.07)
	Ant.III	0.64 (0.59-0.73)
	Ant.IV	0.40 (0.37-0.43)
	Ant.V	0.35 (0.31-0.38)
	Ant.VIb	0.22 (0.17-0.27)
	PT	0.33 (0.30-0.35)
	URS	0.10 (0.09-0.11)
	HFM	0.57 (0.50-0.61)
	HTB	1.15 (1.02-1.30)
	2HT	0.13 (0.11-0.14)
	SIPH	0.11 (0.09-0.12)
	Cauda	0.12 (0.10-0.14)
	Longest setae on Ant.III	0.01 (0.01-0.02)
No. of setae on	Ant.I	3 (3-4)
	Ant.II	3
	Ant.III	10 (8-11)
	Ant.VIb	1
	URS (accessory setae)	7 (5-8)
	SIPH	0
	8th abdominal tergite	6 (5-7)
	Cauda knob	14 (12-15)
	Each lobe of anal plate	15 (14-16)
No. of rhinaria on	Ant.III	8 (5-12)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.98 (0.87-1.08)
	PT / Ant.VIb	1.55 (1.19-1.94)
	PT / Ant.III	0.52 (0.44-0.59)
	URS / 2HT	0.80 (0.69-0.92)
	URS / Ant.VIb	0.47 (0.41-0.55)
	SIPH / Body length	0.05 (0.05-0.06)
	SIPH / Ant.III	0.18 (0.15-0.20)
	SIPH / HFM	0.20 (0.17-0.24)
	SIPH / Cauda	0.91 (0.85-1.00)
	Setae on Ant.III / BDAnt.III	0.47 (0.33-0.67)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S41. Biometric data of *Chromaphis juglandicola* (Kaltenbach) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.74 (1.38-1.91)
	Whole Antennae	0.92 (0.83-0.99)
	Ant.I	0.05 (0.04-0.06)
	Ant.II	0.05 (0.05-0.06)
	Ant.III	0.34 (0.29-0.37)
	Ant.IV	0.18 (0.16-0.21)
	Ant.V	0.16 (0.14-0.18)
	Ant.VIb	0.10 (0.07-0.12)
	PT	0.03 (0.02-0.03)
	URS	0.07 (0.06-0.07)
	HFM	0.39 (0.36-0.41)
	HTB	0.72 (0.63-0.80)
	2HT	0.09 (0.08-0.10)
	SIPH	0.04 (0.03-0.06)
	Cauda	0.07 (0.07-0.08)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	3 (2-3)
	Ant.II	2
	Ant.III	3 (2-4)
	Ant.VIb	1
	URS (accessory setae)	5 (5-6)
	SIPH	3 (2-3)
	8th abdominal tergite	11 (9-13)
	Cauda knob	14 (13-16)
	Each lobe of anal plate	11 (10-13)
No. of rhinaria on	Ant.III	7 (5-9)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.53 (0.49-0.60)
	PT / Ant.VIb	0.26 (0.18-0.30)
	PT / Ant.III	0.08 (0.05-0.10)
	URS / 2HT	0.75 (0.60-0.88)
	URS / Ant.VIb	0.65 (0.55-0.70)
	SIPH / Body length	0.02 (0.02-0.03)
	SIPH / Ant.III	0.11 (0.10-0.14)
	SIPH / HFM	0.11 (0.08-0.15)
	SIPH / Cauda	0.63 (0.43-0.86)
	Setae on Ant.III / BDAnt.III	0.05

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S42. Biometric data of *Chromocallis nirecola* (Shinji) from Korea

	Body parts	Alate viviparous female (n=10)
Length (mm)	Body length	2.91 (2.74-3.03)
	Whole Antennae	1.65 (1.57-1.77)
	Ant.I	0.08 (0.07-0.08)
	Ant.II	0.07 (0.07-0.08)
	Ant.III	0.63 (0.60-0.70)
	Ant.IV	0.29 (0.26-0.31)
	Ant.V	0.29 (0.27-0.30)
	Ant.VIb	0.20 (0.18-0.22
	PT	0.09
	URS	0.13 (0.11-0.14
	HFM	0.76 (0.71-0.82
	HTB	1.90 (1.75-2.05)
	2HT	0.15 (0.14-0.16)
	SIPH	0.11 (0.09-0.13)
	Cauda	0.16 (0.15-0.18)
	Longest setae on Ant.III	0.03
No. of setae on	Ant.I	3 (2-4)
	Ant.II	2 (2-3)
	Ant.III	8 (6-9)
	Ant.VIb	1
	URS (accessory setae)	5 (5-6)
	SIPH	0
	8th abdominal tergite	11 (9-13)
	Cauda knob	20 (19-22)
	Each lobe of anal plate	12 (11-14)
No. of rhinaria on	Ant.III	16 (13-21)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.56 (0.52-0.60)
	PT / Ant.VIb	0.45 (0.41-0.50)
	PT / Ant.III	0.14 (0.13-0.15)
	URS / 2HT	0.88 (0.79-1.00)
	URS / Ant.VIb	0.64 (0.52-0.78)
	SIPH / Body length	0.04 (0.03-0.04)
	SIPH / Ant.III	0.18 (0.16-0.22)
	SIPH / HFM	0.15 (0.13-0.17)
	SIPH / Cauda	0.66 (0.56-0.73)
	Setae on Ant.III / BDAnt.III	1.00

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S43. Biometric data of *Dasyaphis rhusae* (Shinji) from Korea

	Body parts	Apterous viviparous female (n=20)
Length (mm)	Body length	1.22 (1.15-1.33)
	Whole Antennae	0.22 (0.20-0.25)
	Ant.I	0.03 (0.03-0.04)
	Ant.II	0.03 (0.02-0.03)
	Basal segment of Ant.III	0.14 (0.13-0.16)
	PT	0.02 (0.01-0.02)
	URS	0.04 (0.03-0.05)
	HFM	0.17 (0.15-0.18)
	HTB	0.25 (0.21-0.31)
	2HT	0.06 (0.05-0.07)
	SIPH	0.01
	Cauda	0.08 (0.07-0.10)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	1 (1-2)
	Ant.II	1 (1-2)
	Basal segment of Ant.III	3 (2-5)
	URS (accessory setae)	0
	SIPH	0
	8th abdominal tergite	10 (9-10)
	Cauda knob	16 (10-20)
	Each lobe of anal plate	8 (6-10)
No. of rhinaria on	Ant.III	1
Ratio (times)	Antennae / Body length	0.18 (0.17-0.20)
	PT / Basal segment of Ant.III	0.12 (0.07-0.15)
	URS / 2HT	0.72 (0.50-0.83)
	URS / Basal segment of Ant.III	0.30 (0.19-0.36)
	SIPH / Body length	0.01
	SIPH / Basal segment of Ant.III	0.07 (0.06-0.08)
	SIPH / HFM	0.06 (0.06-0.07)
	SIPH / Cauda	0.12 (0.10-0.14)
	Setae on Ant.III / BDAnt.III	0.50

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S44. Biometric data of *Mesocallis* (*M.*) *carpinicola* Lee, sp. nov. from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.37 (1.30-1.55)
	Whole Antennae	1.00 (0.92-1.05)
	Ant.I	0.05 (0.05-0.06)
	Ant.II	0.05 (0.04-0.05)
	Ant.III	0.33 (0.29-0.36)
	Ant.IV	0.22 (0.21-0.23)
	Ant.V	0.18 (0.17-0.20)
	Ant.VIb	0.10 (0.09-0.11)
	PT	0.07 (0.06-0.08)
	URS	0.10 (0.10-0.11)
	HFM	0.34 (0.31-0.37)
	HTB	0.55 (0.51-0.59)
	2HT	0.08 (0.08-0.09)
	SIPH	0.05 (0.05-0.06)
	Cauda	0.08 (0.07-0.09)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	3
	Ant.II	3 (3-4)
	Ant.III	4 (4-5)
	Ant.VIb	1
	URS (accessory setae)	5 (4-6)
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	12 (10-15)
	Each lobe of anal plate	7 (6-8)
No. of rhinaria on	Ant.III	14 (12-16)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.73 (0.66-0.78)
	PT / Ant.VIb	0.72 (0.60-0.80)
	PT / Ant.III	0.21 (0.19-0.24)
	URS / 2HT	1.28 (1.22-1.38)
	URS / Ant.VIb	1.08 (1.00-1.22)
	SIPH / Body length	0.04 (0.03-0.04)
	SIPH / Ant.III	0.16 (0.14-0.18)
	SIPH / HFM	0.16 (0.14-0.18)
	SIPH / Cauda	0.64 (0.56-0.75)
	Setae on Ant.III / BDAnt.III	0.50

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S45. Biometric data of *Mesocallis* (*M.*) *pteleae* Matsumura from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.65 (1.51-1.76)
	Whole Antennae	1.13 (1.07-1.23)
	Ant.I	0.06 (0.05-0.07)
	Ant.II	0.06 (0.05-0.06)
	Ant.III	0.36 (0.33-0.43)
	Ant.IV	0.24 (0.23-0.27)
	Ant.V	0.19 (0.18-0.22)
	Ant.VIb	0.11 (0.09-0.14)
	PT	0.09 (0.08-0.10)
	URS	0.12 (0.11-0.14)
	HFM	0.40 (0.37-0.45)
	HTB	0.71 (0.65-0.80)
	2HT	0.09 (0.08-0.10)
	SIPH	0.05 (0.03-0.06)
	Cauda	0.10 (0.09-0.11)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	4 (3-4)
	Ant.II	3 (2-4)
	Ant.III	7 (5-9)
	Ant.VIb	1
	URS (accessory setae)	8 (8-9)
	SIPH	1
	8th abdominal tergite	2 (2-3)
	Cauda knob	8 (7-11)
	Each lobe of anal plate	8 (7-10)
No. of rhinaria on	Ant.III	14 (13-16)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.68 (0.63-0.74)
	PT / Ant.VIb	0.82 (0.71-0.91)
	PT / Ant.III	0.26 (0.21-0.29)
	URS / 2HT	1.38 (1.22-1.50)
	URS / Ant.VIb	1.09 (0.86-1.27)
	SIPH / Body length	0.03 (0.02-0.03)
	SIPH / Ant.III	0.11 (0.09-0.14)
	SIPH / HFM	0.10 (0.08-0.13)
	SIPH / Cauda	0.40 (0.33-0.45)
	Setae on Ant.III / BDAnt.III	0.37 (0.35-0.40)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S46. Biometric data of *Mesocallis* (*M.*) *sawashibae* (Matsumura) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.54 (1.27-1.77)
	Whole Antennae	1.08 (0.91-1.14)
	Ant.I	0.06 (0.05-0.07)
	Ant.II	0.06 (0.05-0.06)
	Ant.III	0.36 (0.30-0.39)
	Ant.IV	0.23 (0.19-0.26)
	Ant.V	0.18 (0.15-0.19)
	Ant.VIb	0.09 (0.08-0.11)
	PT	0.10 (0.08-0.11)
	URS	0.07 (0.06-0.08)
	HFM	0.35 (0.30-0.42)
	HTB	0.53 (0.45-0.64)
	2HT	0.08 (0.08-0.09)
	SIPH	0.05 (0.04-0.06)
	Cauda	0.11 (0.08-0.11)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	3
	Ant.II	2 (2-3)
	Ant.III	7 (6-11)
	Ant.VIb	1
	URS (accessory setae)	4 (4-5)
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	12 (11-13)
	Each lobe of anal plate	7 (5-10)
No. of rhinaria on	Ant.III	9 (6-12)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.70 (0.64-0.76)
	PT / Ant.VIb	1.07 (0.80-1.25)
	PT / Ant.III	0.27 (0.21-0.32)
	URS / 2HT	0.87 (0.67-1.00)
	URS / Ant.VIb	0.79 (0.60-0.89)
	SIPH / Body length	0.03 (0.03-0.04)
	SIPH / Ant.III	0.14 (0.12-0.15)
	SIPH / HFM	0.13 (0.12-0.16)
	SIPH / Cauda	0.50 (0.44-0.60)
	Setae on Ant.III / BDAnt.III	0.50

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S47. Biometric data of *Mesocallis* (*P.*) *corylicola* (Higuchi) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.40 (1.24-1.61)
	Whole Antennae	1.16 (1.02-1.29)
	Ant.I	0.06 (0.05-0.06)
	Ant.II	0.05 (0.05-0.06)
	Ant.III	0.34 (0.28-0.40)
	Ant.IV	0.26 (0.23-0.32)
	Ant.V	0.22 (0.19-0.25)
	Ant.VIb	0.12 (0.10-0.13)
	PT	0.12 (0.11-0.13)
	URS	0.09 (0.08-0.09)
	HFM	0.35 (0.30-0.39)
	HTB	0.64 (0.55-0.70)
	2HT	0.09 (0.08-0.11)
	SIPH	0.06 (0.05-0.07)
	Cauda	0.09 (0.08-0.10)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	3 (3-4)
	Ant.II	3 (2-3)
	Ant.III	5 (4-6)
	Ant.VIb	1
	URS (accessory setae)	4 (4-5)
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	13 (10-14)
	Each lobe of anal plate	9 (6-11)
No. of rhinaria on	Ant.III	10 (7-12)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.83 (0.75-0.92)
	PT / Ant.VIb	1.02 (0.92-1.10)
	PT / Ant.III	0.35 (0.30-0.39)
	URS / 2HT	0.93 (0.80-1.00)
	URS / Ant.VIb	0.75 (0.69-0.90)
	SIPH / Body length	0.04 (0.03-0.06)
	SIPH / Ant.III	0.18 (0.13-0.22)
	SIPH / HFM	0.17 (0.13-0.20)
	SIPH / Cauda	0.66 (0.50-0.78)
	Setae on Ant.III / BDAnt.III	0.57 (0.50-1.00)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S48. Biometric data of *Mesocallis* (*P.*) *occultus* Lee, sp. nov. from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.26 (0.95-1.44)
	Whole Antennae	0.87 (0.73-1.07)
	Ant.I	0.05 (0.04-0.06)
	Ant.II	0.05 (0.04-0.06)
	Ant.III	0.26 (0.21-0.33)
	Ant.IV	0.17 (0.12-0.22)
	Ant.V	0.15 (0.13-0.18)
	Ant.VIb	0.10 (0.08-0.12)
	PT	0.09 (0.08-0.11)
	URS	0.08 (0.07-0.09)
	HFM	0.28 (0.23-0.32)
	HTB	0.52 (0.41-0.63)
	2HT	0.08 (0.07-0.09)
	SIPH	0.05 (0.04-0.06)
	Cauda	0.08 (0.07-0.09)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	4 (3-5)
	Ant.II	3 (2-3)
	Ant.III	4 (3-4)
	Ant.VIb	1
	URS (accessory setae)	5 (4-6)
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	11 (9-13)
	Each lobe of anal plate	8 (7-10)
No. of rhinaria on	Ant.III	6 (5-9)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.69 (0.60-0.77)
	PT / Ant.VIb	0.95 (0.83-1.10)
	PT / Ant.III	0.36 (0.33-0.38)
	URS / 2HT	1.04 (1.00-1.14)
	URS / Ant.VIb	0.84 (0.75-1.00)
	SIPH / Body length	0.05 (0.03-0.07)
	SIPH / Ant.III	0.23 (0.15-0.33)
	SIPH / HFM	0.21 (0.16-0.30)
	SIPH / Cauda	0.67 (0.56-0.86)
	Setae on Ant.III / BDAnt.III	0.58 (0.50-1.00)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S49. Biometric data of *Monelliopsis caryae* (Monell) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.82 (1.72-1.90)
	Whole Antennae	1.23 (1.13-1.31)
	Ant.I	0.06 (0.04-0.06)
	Ant.II	0.07 (0.05-0.07)
	Ant.III	0.35 (0.32-0.37)
	Ant.IV	0.25 (0.23-0.27)
	Ant.V	0.24 (0.21-0.26)
	Ant.VIb	0.14 (0.12-0.15)
	PT	0.15 (0.14-0.16)
	URS	0.09 (0.09-0.10)
	HFM	0.39 (0.38-0.41)
	HTB	0.67 (0.64-0.70)
	2HT	0.09 (0.08-0.09)
	SIPH	0.01
	Cauda	0.10 (0.09-0.11)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	3 (3-4)
	Ant.II	2
	Ant.III	5
	Ant.VIb	1
	URS (accessory setae)	6 (5-7)
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	8 (7-9)
	Each lobe of anal plate	8 (6-9)
No. of rhinaria on	Ant.III	()
	Ant. IV	()
	Ant. V	()
Ratio (times)	Antennae / Body length	0.68 (0.65-0.72)
	PT / Ant.VIb	1.11 (1.00-1.25)
	PT / Ant.III	0.43 (0.40-0.50)
	URS / 2HT	1.07 (1.00-1.33)
	URS / Ant.VIb	0.71 (1.00-1.13)
	SIPH / Body length	0.01
	SIPH / Ant.III	0.03
	SIPH / HFM	0.03 (0.02-0.03)
	SIPH / Cauda	0.10 (0.09-0.11)
	Setae on Ant.III / BDAnt.III	0.50

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S50. Biometric data of *Neochromaphis carpinicola* (Takahashi) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.51 (1.26-1.72)
	Whole Antennae	0.83 (0.67-0.96)
	Ant.I	0.05 (0.05-0.06)
	Ant.II	0.05 (0.04-0.06)
	Ant.III	0.26 (0.20-0.30)
	Ant.IV	0.18 (0.13-0.23)
	Ant.V	0.16 (12-0.19)
	Ant.VIb	0.11 (0.09-0.12)
	PT	0.01
	URS	0.09 (0.08-0.10)
	HFM	0.25 (0.21-0.29)
	HTB	0.52 (0.42-0.58)
	2HT	0.09 (0.07-0.10)
	SIPH	0.03 (0.02-0.03)
	Cauda	0.03 (0.02-0.03)
	Longest setae on Ant.III	0.02
No. of setae on	Ant.I	3 (2-3)
	Ant.II	2
	Ant.III	5 (4-6)
	Ant.VIb	1
	URS (accessory setae)	5 (4-5)
	SIPH	0
	8th abdominal tergite	5 (4-6)
	Cauda knob	11 (10-13)
	Each lobe of anal plate	8 (7-9)
No. of rhinaria on	Ant.III	4 (3-5)
	Ant. IV	0 (0-1)
	Ant. V	1
Ratio (times)	Antennae / Body length	0.56 (0.52-0.66)
	PT / Ant.VIb	0.09 (0.08-0.11)
	PT / Ant.III	0.04 (0.03-0.05)
	URS / 2HT	1.04 (0.89-1.13)
	URS / Ant.VIb	0.83 (0.73-1.00)
	SIPH / Body length	0.02 (0.01-0.02)
	SIPH / Ant.III	0.10 (0.07-0.15)
	SIPH / HFM	0.10 (0.08-0.14)
	SIPH / Cauda	0.22 (0.15-0.33)
	Setae on Ant.III / BDAnt.III	1.00

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S51. Biometric data of *Neochromaphis coryli* (Takahashi) from Korea

	Body parts	Alate viviparous female (n=12)
Length (mm)	Body length	1.87 (1.70-2.12)
	Whole Antennae	1.01 (0.98-1.03)
	Ant.I	0.06 (0.06-0.07)
	Ant.II	0.06
	Ant.III	0.36 (0.33-0.38)
	Ant.IV	0.19 (0.18-0.22)
	Ant.V	0.18 (0.17-0.19)
	Ant.VIb	0.13 (0.12-0.14)
	PT	0.02
	URS	0.15 (0.15-0.16)
	HFM	0.39 (0.38-0.40)
	HTB	0.80 (0.76-0.83)
	2HT	0.12 (0.10-0.12)
	SIPH	0.04 (0.03-0.06)
	Cauda	0.13 (0.12-0.14)
	Longest setae on Ant.III	0.06 (0.06-0.07)
No. of setae on	Ant.I	3 (2-3)
	Ant.II	2
	Ant.III	9 (6-13)
	Ant.VIb	2 (2-3)
	URS (accessory setae)	10 (9-11)
	SIPH	2
	8th abdominal tergite	6 (4-7)
	Cauda knob	13
	Each lobe of anal plate	11 (9-13)
No. of rhinaria on	Ant.III	13 (10-15)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.54 (0.49-0.60)
	PT / Ant.VIb	0.16 (0.14-0.17)
	PT / Ant.III	0.06 (0.05-0.06)
	URS / 2HT	1.33 (1.25-1.50)
	URS / Ant.VIb	0.86 (0.68-1.07)
	SIPH / Body length	0.02 (0.02-0.03)
	SIPH / Ant.III	0.12 (0.08-0.17)
	SIPH / HFM	0.11 (0.08-0.15)
	SIPH / Cauda	0.34 (0.23-0.46)
	Setae on Ant.III / BDAnt.III	3.25 (3.00-3.50)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S52. Biometric data of *Panaphis juglandis* (Goeze) from Korea

	Body parts	Alate viviparous female (n=2)
Length (mm)	Body length	3.36 (3.28-3.44)
	Whole Antennae	1.53 (1.44-1.58)
	Ant.I	0.08 (0.08-0.09)
	Ant.II	0.08 (0.07-0.08)
	Ant.III	0.72 (0.68-0.74)
	Ant.IV	0.29 (0.27-0.31)
	Ant.V	0.22 (0.20-0.23)
	Ant.VIb	0.09
	PT	0.05 (0.04-0.05)
	URS	0.16 (0.15-0.16)
	HFM	1.14 (1.10-1.17)
	HTB	2.27 (2.16-2.37)
	2HT	0.17 (0.16-0.189)
	SIPH	0.12 (0.11-0.12)
	Cauda	0.12 (0.11-0.12)
	Longest setae on Ant.III	0.12 (0.11-0.13)
No. of setae on	Ant.I	4 (3-4)
	Ant.II	1
	Ant.III	24 (22-25)
	Ant.VIb	1
	URS (accessory setae)	14 (13-14)
	SIPH	5 (4-6)
	8th abdominal tergite	9 (8-9)
	Cauda knob	47 (45-50)
	Each lobe of anal plate	38 (35-40)
No. of rhinaria on	Ant.III	20 (18-23)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.45 (0.44-0.46)
	PT / Ant.VIb	0.52 (0.44-0.56)
	PT / Ant.III	0.07 (0.05-0.07)
	URS / 2HT	0.91 (0.89-0.94)
	URS / Ant.VIb	1.72 (1.67-1.78)
	SIPH / Body length	0.03
	SIPH / Ant.III	0.16
	SIPH / HFM	0.10
	SIPH / Cauda	0.37 (0.37-0.38)
	Setae on Ant.III / BDAnt.III	3.00 (2.75-3.25)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S53. Biometric data of *Pseudochromaphis coreana* (Paik) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.48 (1.36-1.57)
	Whole Antennae	1.11 (0.98-1.19)
	Ant.I	0.06 (0.06-0.07)
	Ant.II	0.06 (0.05-0.06)
	Ant.III	0.42 (0.37-0.48)
	Ant.IV	0.22 (0.17-0.25)
	Ant.V	0.19 (0.17-0.20)
	Ant.VIb	0.12 (0.11-0.13)
	PT	0.04 (0.03-0.05)
	URS	0.08 (0.07-0.09)
	HFM	0.32 (0.29-0.35)
	HTB	0.61 (0.50-0.70)
	2HT	0.08 (0.07-0.09)
	SIPH	0.06 (0.05-0.08)
	Cauda	0.08 (0.07-0.09)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	4 (4-5)
	Ant.II	3 (2-3)
	Ant.III	11 (9-13)
	Ant.VIb	1
	URS (accessory setae)	4 (4-5)
	SIPH	1 (1-2)
	8th abdominal tergite	2 (2-3)
	Cauda knob	9 (9-10)
	Each lobe of anal plate	6 (5-7)
No. of rhinaria on	Ant.III	4 (2-9)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.73 (0.70-0.77)
	PT / Ant.VIb	0.35 (0.23-0.45)
	PT / Ant.III	0.10 (0.07-0.13)
	URS / 2HT	1.01 (0.89-1.14)
	URS / Ant.VIb	0.69 (0.62-0.75)
	SIPH / Body length	0.04 (0.04-0.05)
	SIPH / Ant.III	0.15 (0.13-0.17)
	SIPH / HFM	0.19 (0.17-0.23)
	SIPH / Cauda	0.73 (0.56-1.00)
	Setae on Ant.III / BDAnt.III	0.50

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S54. Biometric data of *Pterocallis* (*P.*) *heterophylla* Quednau from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.35 (1.27-1.44)
	Whole Antennae	0.62 (0.52-0.68)
	Ant.I	0.06 (0.05-0.07)
	Ant.II	0.06 (0.05-0.06)
	Ant.III	0.36 (0.30-0.41)
	Ant.IV	0.23 (0.21-0.26)
	Ant.V	0.19 (0.17-0.21)
	Ant.VIb	0.12 (0.11-0.13)
	PT	0.08 (0.07-0.09)
	URS	0.04 (0.04-0.05)
	HFM	0.25 (0.23-0.27)
	HTB	0.50 (0.43-0.59)
	2HT	0.09 (0.08-0.10)
	SIPH	0.01 (0.01-0.02)
	Cauda	0.14 (0.13-0.15)
	Longest setae on Ant.III	0.01 (0.01-0.02)
No. of setae on	Ant.I	3 (2-4)
	Ant.II	2 (2-3)
	Ant.III	4 (3-5)
	Ant.VIb	1
	URS (accessory setae)	0
	SIPH	0
	8th abdominal tergite	6 (5-8)
	Cauda knob	13 (11-14)
	Each lobe of anal plate	2
No. of rhinaria on	Ant.III	4 (3-5)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.82 (0.79-0.88)
	PT / Ant.VIb	0.59 (0.54-0.67)
	PT / Ant.III	0.19 (0.17-0.21)
	URS / 2HT	0.28 (0.20-0.44)
	URS / Ant.VIb	0.35 (0.31-0.38)
	SIPH / Body length	0.01 (0.01-0.02)
	SIPH / Ant.III	0.03 (0.02-0.05)
	SIPH / HFM	0.05 (0.04-0.07)
	SIPH / Cauda	0.09 (0.07-0.14)
	Setae on Ant.III / BDAnt.III	0.63 (0.50-1.00)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S55. Biometric data of *Pterocallis* (*R*.) *alnijaponicae* Matsumura from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.63 (1.46-1.85)
	Whole Antennae	1.35 (1.22-1.48)
	Ant.I	0.06 (0.05-0.07)
	Ant.II	0.06 (0.05-0.07)
	Ant.III	0.44 (0.40-0.51)
	Ant.IV	0.30 (0.26-0.36)
	Ant.V	0.26 (0.22-0.27)
	Ant.VIb	0.13 (0.11-0.14)
	PT	0.10 (0.08-0.12)
	URS	0.08 (0.07-0.08)
	HFM	0.36 (0.29-0.42)
	HTB	0.69 (0.58-0.77)
	2HT	0.09 (0.08-0.09)
	SIPH	0.05 (0.04-0.06)
	Cauda	0.11 (0.09-0.12)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	3 (2-4)
	Ant.II	3 (2-3)
	Ant.III	10 (6-13)
	Ant.VIb	1
	URS (accessory setae)	4
	SIPH	0
	8th abdominal tergite	6 (5-7)
	Cauda knob	11 (10-12)
	Each lobe of anal plate	8 (7-9)
No. of rhinaria on	Ant.III	5 (4-7)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.83 (0.77-0.90)
	PT / Ant.VIb	0.82 (0.62-1.00)
	PT / Ant.III	0.24 (0.19-0.30)
	URS / 2HT	0.89 (0.78-1.00)
	URS / Ant.VIb	0.58 (0.50-0.62)
	SIPH / Body length	0.03 (0.03-0.04)
	SIPH / Ant.III	0.12 (0.10-0.12)
	SIPH / HFM	0.14 (0.13-0.15)
	SIPH / Cauda	0.48 (0.42-0.56)
	Setae on Ant.III / BDAnt.III	0.46 (0.33-0.50)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S56. Biometric data of *Pterocallis* (*R*.) *nigrostriata* (Shinji) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.69 (1.52-1.81)
	Whole Antennae	1.51 (1.43-1.59)
	Ant.I	0.06 (0.06-0.07)
	Ant.II	0.07 (0.06-0.07)
	Ant.III	0.47 (0.44-0.49)
	Ant.IV	0.32 (0.30-0.35)
	Ant.V	0.30 (0.28-0.33)
	Ant.VIb	0.16 (0.15-0.17)
	PT	0.12 (0.11-0.14)
	URS	0.09
	HFM	0.40 (0.37-0.41)
	HTB	0.69 (0.63-0.74)
	2HT	0.10 (0.09-0.11)
	SIPH	0.07 (0.06-0.10)
	Cauda	0.13 (0.12-0.15)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	3 (2-3)
	Ant.II	3 (2-4)
	Ant.III	7 (6-9)
	Ant.VIb	1
	URS (accessory setae)	4 (4-5)
	SIPH	0
	8th abdominal tergite	6 (5-7)
	Cauda knob	11 (8-14)
	Each lobe of anal plate	9 (7-12)
No. of rhinaria on	Ant.III	4 (3-4)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.90 (0.86-0.96)
	PT / Ant.VIb	0.78 (0.69-0.88)
	PT / Ant.III	0.26 (0.22-0.29)
	URS / 2HT	0.93 (0.82-1.00)
	URS / Ant.VIb	0.56 (0.53-0.60)
	SIPH / Body length	0.04 (0.03-0.06)
	SIPH / Ant.III	0.15 (0.13-0.20)
	SIPH / HFM	0.18 (0.15-0.24)
	SIPH / Cauda	0.54 (0.50-0.67)
	Setae on Ant.III / BDAnt.III	0.50

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S57. Biometric data of *Sarucallis kahawaluokalani* (Kirkaldy) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.26 (1.13-1.42)
	Whole Antennae	1.02 (0.93-1.08)
	Ant.I	0.06 (0.04-0.06)
	Ant.II	0.06 (0.05-0.06)
	Ant.III	0.28 (0.26-0.30)
	Ant.IV	0.21 (0.17-0.23)
	Ant.V	0.18 (0.16-0.20)
	Ant.VIb	0.12 (0.09-0.14)
	PT	0.11 (0.10-0.13)
	URS	0.07 (0.07-0.08)
	HFM	0.30 (0.27-0.32)
	HTB	0.49 (0.46-0.55)
	2HT	0.07
	SIPH	0.04 (0.03-0.05)
	Cauda	0.09 (0.08-0.10)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	3
	Ant.II	2
	Ant.III	5 (5-6)
	Ant.VIb	1
	URS (accessory setae)	4 (3-5)
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	8 (7-9)
	Each lobe of anal plate	7 (6-8)
No. of rhinaria on	Ant.III	6 (6-8)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.81 (0.75-0.89)
	PT / Ant.VIb	0.88 (0.79-1.09)
	PT / Ant.III	0.39 (0.38-0.41)
	URS / 2HT	1.03 (1.00-1.14)
	URS / Ant.VIb	0.58 (0.50-0.64)
	SIPH / Body length	0.03 (0.02-0.04)
	SIPH / Ant.III	0.14 (0.10-0.18)
	SIPH / HFM	0.14 (0.10-0.16)
	SIPH / Cauda	0.45 (0.33-0.56)
	Setae on Ant.III / BDAnt.III	0.50

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S58. Biometric data of *Shivaphis* (*Sh*.) *catalpinari* Quednau & Remaudière from Korea

	Body parts	Alate viviparous female (n=2)
Length (mm)	Body length	1.74 (1.68-1.80)
	Whole Antennae	1.30 (1.28-1.32)
	Ant.I	0.08 (0.07-0.08)
	Ant.II	0.08 (0.07-0.08)
	Ant.III	0.52 (0.51-0.52)
	Ant.IV	0.23 (0.22-0.24)
	Ant.V	0.21 (0.20-0.21)
	Ant.VIb	0.17
	PT	0.03
	URS	0.10
	HFM	0.52 (0.50-0.53)
	HTB	0.82 (0.81-0.83)
	2HT	0.13 (0.12-0.13)
	SIPH	0.01
	Cauda	0.11 (0.10-0.12)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	5 (4-5)
	Ant.II	5 (4-6)
	Ant.III	19 (18-19)
	Ant.VIb	1
	URS (accessory setae)	9 (8-9)
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	9 (9-10)
	Each lobe of anal plate	7 (6-8)
No. of rhinaria on	Ant.III	22 (21-23)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.75 (0.73-0.76)
	PT / Ant.VIb	0.18
	PT / Ant.III	0.06
	URS / 2HT	0.80 (0.77-0.83)
	URS / Ant.VIb	0.59
	SIPH / Body length	0.01
	SIPH / Ant.III	0.02
	SIPH / HFM	0.02
	SIPH / Cauda	0.09 (0.08-0.10)
	Setae on Ant.III / BDAnt.III	0.50

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S59. Biometric data of *Shivaphis* (*Sh.*) *celti* Das from Korea

	Body parts	Apterous viviparous female (n=20)	Alate viviparous female (n=20)
Length (mm)	Body length	2.61 (2.40-2.85)	2.65 (2.51-2.85)
	Whole Antennae	1.42 (1.26-1.80)	1.79 (1.63-1.92)
	Ant.I	0.10 (0.08-0.10)	0.10 (0.08-0.10)
	Ant.II	0.09 (0.08-0.10)	0.08 (0.07-0.08)
	Ant.III	0.51 (0.45-0.64)	0.67 (0.60-0.75)
	Ant.IV	0.25 (0.19-0.35)	0.33 (0.29-0.35)
	Ant.V	0.25 (0.21-0.34)	0.34 (0.31-0.36)
	Ant.VIb	0.20 (0.18-0.24)	0.25 (0.23-0.25)
	PT	0.03 (0.03-0.04)	0.04 (0.03-0.04)
	URS	0.10	0.10 (0.09-0.10)
	HFM	0.65 (0.52-0.68)	0.76 (0.72-0.79)
	HTB	0.89 (0.85-0.94)	1.16 (1.11-1.20)
	2HT	0.15 (0.14-0.16)	0.15 (0.14-0.15)
	SIPH	0.01 (0.01-0.02)	0.01 (0.01-0.02)
	Cauda	0.16 (0.13-0.17)	0.19 (0.17-0.20)
	Longest setae on Ant.III	0.02 (0.01-0.02)	0.01 (0.01-0.02)
No. of setae on	Ant.I	3 (3-4)	4 (3-4)
	Ant.II	2 (2-3)	3 (3-4)
	Ant.III	11 (9-13)	12 (9-15)
	Ant.VIb	1	1
	URS (accessory setae)	6 (6-7)	6 (6-7)
	SIPH	0	0
	8th abdominal tergite	2	2
	Cauda knob	8 (7-8)	9 (7-10)
	Anal plate	11 (8-12)	14 (12-16)
No. of rhinaria on	Ant.III	0	9 (7-10)
	Ant. IV	0	0
	Ant. V	1	1
Ratio (times)	Antennae / Body length	0.51 (0.46-0.54)	0.68 (0.65-0.71)
	PT / Ant.VIb	0.20 (0.17-0.22)	0.15 (0.12-0.17)
	PT / Ant.III	0.07 (0.06-0.09)	0.06 (0.04-0.07)
	URS / 2HT	0.68 (0.67-0.71)	0.67 (0.64-0.71)
	URS / Ant.VIb	0.54 (0.50-0.56)	0.40 (0.39-0.40)
	SIPH / Body length	0.01	0.01
	SIPH / Ant.III	0.02 (0.02-0.04)	0.02 (0.01-0.03)
	SIPH / HFM	0.02 (0.01-0.03)	0.02 (0.01-0.03)
	SIPH / Cauda	0.08 (0.06-0.13)	0.08 (0.05-0.12)
	Setae on Ant.III / BDAnt.III	0.40 (0.25-0.50)	0.36 (0.20-0.50)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S60. Biometric data of *S.* (*Sh.*) *sinensis* Lee, sp. nov. from Korea

	Body parts	Alate viviparous female (n=5)
Length (mm)	Body length	2.26 (2.15-2.46)
	Whole Antennae	2.20 (2.11-2.32)
	Ant.I	0.10
	Ant.II	0.09
	Ant.III	0.82 (0.76-0.89)
	Ant.IV	0.45 (0.43-0.48)
	Ant.V	0.41 (0.38-0.43)
	Ant.VIb	0.28 (0.28-0.29)
	PT	0.05 (0.04-0.05)
	URS	0.09 (0.09-0.10)
	HFM	0.83 (0.75-0.90)
	HTB	1.30 (1.21-1.38)
	2HT	0.15 (0.14-0.16)
	SIPH	0.01
	Cauda	0.14 (0.13-0.16)
	Longest setae on Ant.III	0.02
No. of setae on	Ant.I	2 (2-3)
	Ant.II	3
	Ant.III	25 (21-27)
	Ant.VIb	1
	URS (accessory setae)	8 (7-8)
	SIPH	0
	8th abdominal tergite	6 (5-6)
	Cauda knob	9 (8-10)
	Each lobe of anal plate	16 (16-17)
No. of rhinaria on	Ant.III	17 (16-18)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.94 (0.94-1.01)
	PT / Ant.VIb	0.17 (0.14-0.18)
	PT / Ant.III	0.06 (0.04-0.07)
	URS / 2HT	0.62 (0.56-0.67)
	URS / Ant.VIb	0.33 (0.32-0.34)
	SIPH / Body length	0.01
	SIPH / Ant.III	0.01
	SIPH / HFM	0.01
	SIPH / Cauda	0.07 (0.06-0.07)
	Setae on Ant.III / BDAnt.III	0.50

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S61. Biometric data of *Shivaphis* (*Si.*) *szelegiewiczi* Quednau from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.68 (2.31-2.85)
	Whole Antennae	3.29 (3.22-3.36)
	Ant.I	0.11 (0.10-0.13)
	Ant.II	0.08 (0.07-0.09)
	Ant.III	1.08 (1.05-1.15)
	Ant.IV	0.70 (0.68-0.73)
	Ant.V	0.68 (0.63-0.71)
	Ant.VIb	0.44 (0.42-0.46)
	PT	0.20 (0.19-0.20)
	URS	0.12 (0.12-0.13)
	HFM	1.10 (1.06-1.17)
	HTB	1.99 (1.93-2.05)
	2HT	0.15 (0.14-0.16)
	SIPH	0.02
	Cauda	0.15 (0.14-0.16)
	Longest setae on Ant.III	0.02
No. of setae on	Ant.I	4 (3-4)
	Ant.II	3 (2-4)
	Ant.III	22 (21-24)
	Ant.VIb	1 (1-2)
	URS (accessory setae)	14 (12-15)
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	8 (7-8)
	Each lobe of anal plate	8 (8-9)
No. of rhinaria on	Ant.III	19 (18-21)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.22 (1.16-1.42)
	PT / Ant.VIb	0.44 (0.42-0.48)
	PT / Ant.III	0.18 (0.17-0.19)
	URS / 2HT	0.81 (0.80-0.81)
	URS / Ant.VIb	0.29 (0.27-0.30)
	SIPH / Body length	0.01
	SIPH / Ant.III	0.02
	SIPH / HFM	0.02
	SIPH / Cauda	0.13
	Setae on Ant.III / BDAnt.III	0.50

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S62. Biometric data of *Shivaphis* (*Si.*) *tilisucta* (Zhang) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.45 (2.31-2.63)
	Whole Antennae	2.16 (2.02-2.24)
	Ant.I	0.09 (0.08-0.09)
	Ant.II	0.08 (0.07-0.09)
	Ant.III	0.75 (0.70-0.80)
	Ant.IV	0.44 (0.41-0.46)
	Ant.V	0.45 (0.42-0.47)
	Ant.VIb	0.25 (0.23-0.26)
	PT	0.10 (0.09-0.10)
	URS	0.09 (0.09-0.10)
	HFM	0.77 (0.74-0.79)
	HTB	1.31 (1.26-1.36)
	2HT	0.13
	SIPH	0.08 (0.07-0.09)
	Cauda	0.13 (0.12-0.14)
	Longest setae on Ant.III	0.02
No. of setae on	Ant.I	3 (3-4)
	Ant.II	3 (2-3)
	Ant.III	16 (13-18)
	Ant.VIb	1
	URS (accessory setae)	8 (7-9)
	SIPH	1
	8th abdominal tergite	2
	Cauda knob	8 (7-8)
	Each lobe of anal plate	11 (9-12)
No. of rhinaria on	Ant.III	9 (7-11)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.88 (0.85-0.92)
	PT / Ant.VIb	0.39 (0.35-0.43)
	PT / Ant.III	0.13 (0.13-0.14)
	URS / 2HT	1.49 (1.29-1.67)
	URS / Ant.VIb	0.36 (0.35-0.39)
	SIPH / Body length	0.03 (0.03-0.04)
	SIPH / Ant.III	0.11 (0.09-0.13)
	SIPH / HFM	0.11 (0.09-0.12)
	SIPH / Cauda	0.62 (0.57-0.69)
	Setae on Ant.III / BDAnt.III	0.67

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S63. Biometric data of *Takecallis arundicolens* (Clarke) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.67 (1.57-1.89)
	Whole Antennae	2.45 (2.36-2.51)
	Ant.I	0.08 (0.07-0.09)
	Ant.II	0.07 (0.07-0.08)
	Ant.III	0.71 (0.67-0.72)
	Ant.IV	0.49 (0.46-0.51)
	Ant.V	0.47 (0.46-0.48)
	Ant.VIb	0.30 (0.27-0.31)
	PT	0.34 (0.33-0.36)
	URS	0.05 (0.05-0.06)
	HFM	0.43 (0.41-0.46)
	HTB	0.77 (0.72-0.80)
	2HT	0.09 (0.09-0.10)
	SIPH	0.05 (0.04-0.05)
	Cauda	0.14 (0.14-0.15)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	4 (4-5)
	Ant.II	3 (2-3)
	Ant.III	19 (13-23)
	Ant.VIb	1
	URS (accessory setae)	4 (4-5)
	SIPH	1
	8th abdominal tergite	2
	Cauda knob	11 (9-13)
	Each lobe of anal plate	7 (7-8)
No. of rhinaria on	Ant.III	5 (4-7)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.47 (1.30-1.60)
	PT / Ant.VIb	1.16 (1.10-1.26)
	PT / Ant.III	0.49 (0.47-0.50)
	URS / 2HT	0.59 (0.56-0.67)
	URS / Ant.VIb	0.18 (0.16-0.20)
	SIPH / Body length	0.03 (0.02-0.03)
	SIPH / Ant.III	0.07 (0.06-0.07)
	SIPH / HFM	0.11 (0.09-0.12)
	SIPH / Cauda	0.33 (0.27-0.36)
	Setae on Ant.III / BDAnt.III	0.33

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S64. Biometric data of *Takecallis arundinariae* (Essig) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.35 (1.90-2.65)
	Whole Antennae	2.98 (2.54-3.41)
	Ant.I	0.11 (0.09-0.12)
	Ant.II	0.10 (0.09-0.12)
	Ant.III	0.92 (0.70-1.11)
	Ant.IV	0.71 (0.54-0.85)
	Ant.V	0.62 (0.48-0.77)
	Ant.VIb	0.34 (0.26-0.40)
	PT	0.35 (0.31-0.40)
	URS	0.05 (0.05-0.06)
	HFM	0.58 (0.53-0.66)
	HTB	1.05 (0.91-1.21)
	2HT	0.11 (0.10-0.12)
	SIPH	0.07 (0.05-0.08)
	Cauda	0.13 (0.11-0.16)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	4 (3-5)
	Ant.II	3 (2-3)
	Ant.III	23 (18-28)
	Ant.VIb	1
	URS (accessory setae)	4
	SIPH	1
	8th abdominal tergite	2
	Cauda knob	12 (10-15)
	Each lobe of anal plate	9 (8-12)
No. of rhinaria on	Ant.III	7 (5-10)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.31 (1.22-1.39)
	PT / Ant.VIb	1.10 (0.94-1.27)
	PT / Ant.III	0.41 (0.35-0.47)
	URS / 2HT	0.47 (0.42-0.60)
	URS / Ant.VIb	0.16 (0.13-0.23)
	SIPH / Body length	0.03 (0.02-0.03)
	SIPH / Ant.III	0.07 (0.06-0.09)
	SIPH / HFM	0.11 (0.09-0.13)
	SIPH / Cauda	0.49 (0.36-0.64)
	Setae on Ant.III / BDAnt.III	0.28 (0.20-0.33)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S65. Biometric data of *Takecallis longiantennata* Lee, sp. nov. from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.29 (2.08-2.51)
	Whole Antennae	3.56 (3.36-4.00)
	Ant.I	0.12
	Ant.II	0.10 (0.09-0.11)
	Ant.III	1.17 (1.07-1.33)
	Ant.IV	0.78 (0.73-0.91)
	Ant.V	0.64 (0.60-0.69)
	Ant.VIb	0.37 (0.34-0.40)
	PT	0.38 (0.34-0.44)
	URS	0.05
	HFM	0.61 (0.55-0.69)
	HTB	1.00 (0.87-1.15)
	2HT	0.10 (0.10-0.11)
	SIPH	0.10 (0.08-0.11)
	Cauda	0.13 (0.12-0.14)
	Longest setae on Ant.III	0.01 (0.01-0.02)
No. of setae on	Ant.I	5 (5-6)
	Ant.II	2 (2-3)
	Ant.III	32 (24-39)
	Ant.VIb	1
	URS (accessory setae)	4
	SIPH	1
	8th abdominal tergite	2
	Cauda knob	11 (9-12)
	Each lobe of anal plate	8 (7-10)
No. of rhinaria on	Ant.III	5 (4-7)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.57 (1.48-1.70)
	PT / Ant.VIb	1.05 (0.89-1.11)
	PT / Ant.III	0.33 (0.31-0.34)
	URS / 2HT	0.49 (0.45-0.50)
	URS / Ant.VIb	0.14 (0.13-0.15)
	SIPH / Body length	0.04 (0.03-0.04)
	SIPH / Ant.III	0.08 (0.06-0.09)
	SIPH / HFM	0.15 (0.13-0.17)
	SIPH / Cauda	0.70 (0.57-0.79)
	Setae on Ant.III / BDAnt.III	0.30 (0.25-0.50)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S66. Biometric data of *Takecallis obscura* Lee, sp. nov. from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.72 (1.58-1.82)
	Whole Antennae	2.41 (2.21-2.68)
	Ant.I	0.07 (0.07-0.08)
	Ant.II	0.07 (0.07-0.08)
	Ant.III	0.68 (0.57-0.78)
	Ant.IV	0.48 (0.44-0.56)
	Ant.V	0.46 (0.43-0.50)
	Ant.VIb	0.30 (0.29-0.32)
	PT	0.33 (0.32-0.37)
	URS	0.06 (0.05-0.07)
	HFM	0.41 (0.34-0.47)
	HTB	0.74 (0.67-0.82)
	2HT	0.09 (0.09-0.10)
	SIPH	0.05 (0.04-0.06)
	Cauda	0.31 (0.12-0.13)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	4 (4-5)
	Ant.II	3 (2-4)
	Ant.III	17 (15-22)
	Ant.VIb	1
	URS (accessory setae)	4
	SIPH	1
	8th abdominal tergite	2
	Cauda knob	11 (10-15)
	Each lobe of anal plate	7 (7-8)
No. of rhinaria on	Ant.III	5 (4-6)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.40 (1.32-1.47)
	PT / Ant.VIb	1.10 (1.00-1.19)
	PT / Ant.III	0.50 (0.46-0.56)
	URS / 2HT	0.60 (0.50-0.78)
	URS / Ant.VIb	0.18 (0.16-0.24)
	SIPH / Body length	0.03
	SIPH / Ant.III	0.07 (0.07-0.08)
	SIPH / HFM	0.12 (0.11-0.13)
	SIPH / Cauda	0.39 (0.31-0.46)
	Setae on Ant.III / BDAnt.III	0.33

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S67. Biometric data of *Takecallis taiwana* (Takahashi) from Korea

	Body parts	Alate viviparous female (n=14)
Length (mm)	Body length	2.38 (2.21-2.48)
	Whole Antennae	1.78 (1.61-1.88)
	Ant.I	0.08
	Ant.II	0.07 (0.06-0.09)
	Ant.III	0.63 (0.57-0.67)
	Ant.IV	0.34 (0.31-0.36)
	Ant.V	0.30 (0.26-0.33)
	Ant.VIb	0.18 (0.15-0.20)
	PT	0.18 (0.17-0.19)
	URS	0.07
	HFM	0.49 (0.46-0.50)
	HTB	0.85 (0.79-0.88)
	2HT	0.12 (0.11-0.13)
	SIPH	0.05 (0.04-0.05)
	Cauda	0.18 (0.15-0.20)
	Longest setae on Ant.III	0.02 (0.01-0.02)
No. of setae on	Ant.I	4 (3-4)
	Ant.II	3
	Ant.III	19 (17-21)
	Ant.VIb	1
	URS (accessory setae)	4 (4-5)
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	13 (12-13)
	Each lobe of anal plate	10
No. of rhinaria on	Ant.III	6 (5-7)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.75 (0.73-0.79)
	PT / Ant.VIb	0.99 (0.90-1.06)
	PT / Ant.III	3.47 (3.32-3.72)
	URS / 2HT	0.59 (0.54-0.64)
	URS / Ant.VIb	0.39 (0.35-0.44)
	SIPH / Body length	0.02
	SIPH / Ant.III	0.08 (0.07-0.10)
	SIPH / HFM	0.10 (0.09-0.12)
	SIPH / Cauda	0.29 (0.20-0.35)
	Setae on Ant.III / BDAnt.III	0.50 (0.33-0.67)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S68. Biometric data of *Therioaphis* (*P.*) *subalba* Börner from Korea

	Body parts	Alate viviparous female (n=1)
Length (mm)	Body length	2.17
	Whole Antennae	-
	Ant.I	0.09
	Ant.II	0.07
	Ant.III	0.70
	Ant.IV	0.42
	Ant.V	-
	Ant.VIb	-
	PT	-
	URS	0.08
	HFM	0.54
	HTB	0.96
	2HT	0.13
	SIPH	0.05
	Cauda	0.22
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	5
	Ant.II	3
	Ant.III	23
	Ant.VIb	9
	URS (accessory setae)	4
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	12
	Each lobe of anal plate	8
No. of rhinaria on	Ant.III	16
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	-
	PT / Ant.VIb	-
	PT / Ant.III	-
	URS / 2HT	0.62
	URS / Ant.VIb	-
	SIPH / Body length	0.02
	SIPH / Ant.III	0.07
	SIPH / HFM	0.09
	SIPH / Cauda	0.23
	Setae on Ant.III / BDAnt.III	0.33

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S69. Biometric data of *Therioaphis* (*P.*) *trifolii* (Monell) from Korea

	Body parts	Apterous viviparous female (n=11)	Alate viviparous female (n=2)
Length (mm)	Body length	1.75 (1.54-2.08)	2.07 (1.94-2.19)
	Whole Antennae	1.65 (1.39-1.96)	1.97 (1.85-2.08)
	Ant.I	0.09 (0.08-0.10)	0.09 (0.08-.09)
	Ant.II	0.07 (0.06-0.08)	0.07 (0.06-0.07)
	Ant.III	0.53 (0.43-0.64)	0.60 (0.57-0.62)
	Ant.IV	0.34 (0.27-0.42)	0.42 (0.38-0.46)
	Ant.V	0.32 (0.24-0.39)	0.41 (0.37-0.46)
	Ant.VIb	0.17 (0.13-0.20)	0.20 (0.18-0.22)
	PT	0.18 (0.17-0.21)	0.20 (0.18-0.22)
	URS	0.08	0.09 (0.08-0.09)
	HFM	0.41 (0.34-0.47)	0.49 (0.48-0.50)
	HTB	0.71 (0.55-0.92)	0.94 (0.93-0.94)
	2HT	0.11 (0.10-0.12)	0.12
	SIPH	0.05 (0.04-0.07)	0.06 (0.04-0.07)
	Cauda	0.17 (0.16-0.20)	0.18 (0.17-0.19)
	Longest setae on Ant.III	0.01	0.01
No. of setae on	Ant.I	3 (3-4)	4 (3-4)
	Ant.II	3 (2-3)	3 (2-3)
	Ant.III	16 (13-18)	19 (16-21)
	Ant.VIb	1	1
	URS (accessory setae)	4 (4-5)	5 (4-5)
	SIPH	0	0
	8th abdominal tergite	4 (4-5)	5 (4-5)
	Cauda knob	13 (11-17)	14 (13-15)
	Anal plate	8 (7-9)	8 (7-9)
No. of rhinaria on	Ant.III	7 (6-8)	7 (6-7)
	Ant. IV	0	0
	Ant. V	1	1
Ratio (times)	Antennae / Body length	0.93 (0.86-1.04)	0.95 (0.94-0.95)
	PT / Ant.VIb	1.17 (0.90-1.46)	1.05 (0.95-1.16)
	PT / Ant.III	0.36 (0.28-0.44)	0.34 (0.32-0.35)
	URS / 2HT	0.75 (0.67-0.80)	0.71 (0.67-0.75)
	URS / Ant.VIb	0.50 (0.40-0.62)	0.45 (0.42-0.47)
	SIPH / Body length	0.03 (0.02-0.03)	0.03 (0.02-0.03)
	SIPH / Ant.III	0.10 (0.08-0.11)	0.09 (0.07-0.11)
	SIPH / HFM	0.12 (0.11-0.16)	0.11 (0.08-0.14)
	SIPH / Cauda	0.28 (0.25-0.35)	0.31 (0.21-0.41)
	Setae on Ant.III / BDAnt.III	0.43 (0.33-0.50)	0.50

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S70. Biometric data of *Tiliaphis coreana* Quednau from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.93 (2.60-3.83)
	Whole Antennae	2.27 (2.03-2.62)
	Ant.I	0.10 (0.08-0.12)
	Ant.II	0.08 (0.07-0.10)
	Ant.III	0.71 (0.65-0.79)
	Ant.IV	0.40 (0.33-0.49)
	Ant.V	0.38 (0.30-0.49)
	Ant.VIb	0.28 (0.26-0.31)
	PT	0.35 (0.30-0.41)
	URS	0.10 (0.09-0.10)
	HFM	0.61 (0.57-0.66)
	HTB	1.02 (0.93-1.11)
	2HT	0.12 (0.10-0.13)
	SIPH	0.09 (0.08-0.11)
	Cauda	0.18 (0.14-0.21)
	Longest setae on Ant.III	0.02 (0.02-0.03)
No. of setae on	Ant.I	7 (6-8)
	Ant.II	3 (2-4)
	Ant.III	17 (13-26)
	Ant.VIb	1
	URS (accessory setae)	4 (4-5)
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	13 (11-14)
	Each lobe of anal plate	13 (11-16)
No. of rhinaria on	Ant.III	32 (26-42)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.80 (0.64-0.94)
	PT / Ant.VIb	1.26 (1.07-1.38)
	PT / Ant.III	0.50 (0.39-0.55)
	URS / 2HT	0.84 (0.77-0.91)
	URS / Ant.VIb	0.35 (0.32-0.37)
	SIPH / Body length	0.03
	SIPH / Ant.III	0.13 (0.10-0.14)
	SIPH / HFM	0.15 (0.12-0.17)
	SIPH / Cauda	0.51 (0.38-0.58)
	Setae on Ant.III / BDAnt.III	0.53 (0.50-0.67)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S71. Biometric data of *Tiliaphis pseudoshinae* Quednau from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.94 (1.64-2.22)
	Whole Antennae	1.53 (1.43-1.68)
	Ant.I	0.09 (0.08-0.09)
	Ant.II	0.07 (0.06-0.08)
	Ant.III	0.49 (0.43-0.55)
	Ant.IV	0.35 (0.31-0.41)
	Ant.V	0.34 (0.31-0.41)
	Ant.VIb	0.27 (0.24-0.30)
	PT	0.33 (0.30-0.38)
	URS	0.07 (0.06-0.07)
	HFM	0.43 (0.38-0.51)
	HTB	0.71 (0.62-0.85)
	2HT	0.10 (0.09-0.10)
	SIPH	0.11 (0.09-0.13)
	Cauda	0.12 (0.10-0.14)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	4 (3-5)
	Ant.II	2
	Ant.III	12 (10-14)
	Ant.VIb	1
	URS (accessory setae)	4
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	9 (9-10)
	Each lobe of anal plate	7 (7-8)
No. of rhinaria on	Ant.III	15 (13-17)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.85 (0.83-0.87)
	PT / Ant.VIb	1.27 (1.25-1.28)
	PT / Ant.III	0.71 (0.70-0.73)
	URS / 2HT	0.70 (0.60-0.78)
	URS / Ant.VIb	0.26 (0.23-0.29)
	SIPH / Body length	0.06 (0.05-0.06)
	SIPH / Ant.III	0.22 (0.20-0.24)
	SIPH / HFM	0.25 (0.24-0.26)
	SIPH / Cauda	0.88 (0.69-1.00)
	Setae on Ant.III / BDAnt.III	0.37 (0.33-0.50)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S72. Biometric data of *Tiliaphis shinae* (Shinji) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.71 (1.62-1.83)
	Whole Antennae	1.76 (1.69-1.82)
	Ant.I	0.07 (0.06-0.08)
	Ant.II	0.07 (0.06-0.07)
	Ant.III	0.49 (0.46-0.53)
	Ant.IV	0.29 (0.28-0.32)
	Ant.V	0.29 (0.28-0.32)
	Ant.VIb	0.24 (0.22-0.26)
	PT	0.31 (0.28-0.33)
	URS	0.09 (0.09-0.10)
	HFM	0.38 (0.34-0.41)
	HTB	0.63 (0.59-0.65)
	2HT	0.08 (0.08-0.09)
	SIPH	0.10 (0.09-0.11)
	Cauda	0.10 (0.10-0.11)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	3 (3-4)
	Ant.II	2
	Ant.III	11 (9-14)
	Ant.VIb	1
	URS (accessory setae)	4
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	9 (8-10)
	Each lobe of anal plate	8 (6-8)
No. of rhinaria on	Ant.III	11 (8-13)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.03 (0.98-1.07)
	PT / Ant.VIb	1.32 (1.20-1.43)
	PT / Ant.III	0.63 (0.53-0.69)
	URS / 2HT	1.17 (1.13-1.25)
	URS / Ant.VIb	0.40 (0.36-0.42)
	SIPH / Body length	0.06
	SIPH / Ant.III	0.21 (0.19-0.22)
	SIPH / HFM	0.27 (0.26-0.29)
	SIPH / Cauda	0.98 (0.90-1.00)
	Setae on Ant.III / BDAnt.III	0.50

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S73. Biometric data of *Tiliaphis shinji* Higuchi from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.76 (1.58-2.04)
	Whole Antennae	1.81 (1.68-2.00)
	Ant.I	0.09 (0.08-0.10)
	Ant.II	0.07 (0.06-0.08)
	Ant.III	0.53 (0.50-0.58)
	Ant.IV	0.33 (0.29-0.38)
	Ant.V	0.32 (0.28-0.36)
	Ant.VIb	0.23 (0.21-0.25)
	PT	0.25 (0.23-0.28)
	URS	0.09 (0.08-0.10)
	HFM	0.39 (0.36-0.42)
	HTB	0.69 (0.64-0.76)
	2HT	0.10 (0.09-0.11)
	SIPH	0.09 (0.08-0.11)
	Cauda	0.16 (0.14-0.17)
	Longest setae on Ant.III	0.01 (0.01-0.02)
No. of setae on	Ant.I	5 (4-5)
	Ant.II	3 (2-4)
	Ant.III	17 (15-20)
	Ant.VIb	1
	URS (accessory setae)	6 (4-6)
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	11 (10-12)
	Each lobe of anal plate	7 (6-9)
No. of rhinaria on	Ant.III	13 (12-14)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.04 (0.88-1.15)
	PT / Ant.VIb	1.09 (1.04-1.13)
	PT / Ant.III	0.47 (0.43-0.52)
	URS / 2HT	0.92 (0.82-1.00)
	URS / Ant.VIb	0.41 (0.35-0.48)
	SIPH / Body length	0.05 (0.04-0.06)
	SIPH / Ant.III	0.17 (0.15-0.20)
	SIPH / HFM	0.24 (0.21-0.28)
	SIPH / Cauda	0.58 (0.50-0.67)
	Setae on Ant.III / BDAnt.III	0.40 (0.33-0.67)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S74. Biometric data of *Tinocallis* (*S.*) *saltans* (Nevsky) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.92 (1.72-2.08)
	Whole Antennae	1.48 (1.41-1.54)
	Ant.I	0.08 (0.07-0.08)
	Ant.II	0.06 (0.05-0.07)
	Ant.III	0.51 (0.50-0.52)
	Ant.IV	0.31 (0.27-0.34)
	Ant.V	0.26 (0.24-0.30)
	Ant.VIb	0.14 (0.12-0.16)
	PT	0.11 (0.10-0.11)
	URS	0.10 (0.09-0.11)
	HFM	0.50 (0.47-0.55)
	HTB	0.85 (0.81-0.90)
	2HT	0.11 (0.10-0.12)
	SIPH	0.07 (0.06-0.08)
	Cauda	0.13 (0.13-0.14)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	4 (2-5)
	Ant.II	4 (3-4)
	Ant.III	7 (5-9)
	Ant.VIb	1
	URS (accessory setae)	6
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	12 (11-12)
	Each lobe of anal plate	7 (6-9)
No. of rhinaria on	Ant.III	15 (13-19)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.77 (0.68-0.85)
	PT / Ant.VIb	0.76 (0.67-0.92)
	PT / Ant.III	0.21 (0.19-0.22)
	URS / 2HT	0.91 (0.82-1.00)
	URS / Ant.VIb	0.71 (0.56-0.92)
	SIPH / Body length	0.03 (0.03-0.04)
	SIPH / Ant.III	0.14 (0.12-0.16)
	SIPH / HFM	0.14 (0.12-0.16)
	SIPH / Cauda	0.49 (0.46-0.54)
	Setae on Ant.III / BDAnt.III	0.33

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S75. Biometric data of *Tinocallis* (*S.*) *takachihoensis* Higuchi from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.76 (1.33-2.13)
	Whole Antennae	1.58 (1.22-1.84)
	Ant.I	0.07 (0..06-0.08)
	Ant.II	0.06 (0.05-0.07)
	Ant.III	0.53 (0.33-0.66)
	Ant.IV	0.31 (0.24-0.40)
	Ant.V	0.28 (0.15-0.33)
	Ant.VIb	0.16 (0.14-0.18)
	PT	0.17 (0.14-0.19)
	URS	0.10 (0.09-0.12)
	HFM	0.46 (0.36-0.55)
	HTB	0.86 (0.70-1.01)
	2HT	0.10 (0.09-0.12)
	SIPH	0.05 (0.04-0.06)
	Cauda	0.10 (0.08-0.12)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	3 (3-4)
	Ant.II	3 (2-3)
	Ant.III	8 (7-8)
	Ant.VIb	1
	URS (accessory setae)	6
	SIPH	1
	8th abdominal tergite	2
	Cauda knob	9 (8-9)
	Each lobe of anal plate	6 (5-8)
No. of rhinaria on	Ant.III	19 (16-23)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.93 (0.84-1.05)
	PT / Ant.VIb	1.04 (0.88-1.14)
	PT / Ant.III	0.32 (0.25-0.52)
	URS / 2HT	1.00 (0.83-1.33)
	URS / Ant.VIb	0.64 (0.50-0.73)
	SIPH / Body length	0.03 (0.02-0.03)
	SIPH / Ant.III	0.09 (0.06-0.12)
	SIPH / HFM	0.11 (0.09-0.13)
	SIPH / Cauda	0.46 (0.36-0.55)
	Setae on Ant.III / BDAnt.III	039 (0.33-0.50)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S76. Biometric data of *Tinocallis* (*S.*) *ulmicola* from Korea

	Body parts	Alate viviparous female (n=19)
Length (mm)	Body length	1.64 (1.42-1.91)
	Whole Antennae	1.33 (1.21-1.44)
	Ant.I	0.07 (0.05-0.08)
	Ant.II	0.06 (0.05-0.07)
	Ant.III	0.45 (0.40-0.50)
	Ant.IV	0.28 (0.25-0.34)
	Ant.V	0.22 (0.19-0.25)
	Ant.VIb	0.13 (0.10-0.15)
	PT	0.11 (0.11-0.12)
	URS	0.11 (0.10-0.12)
	HFM	0.43 (0.38-0.49)
	HTB	0.75 (0.64-0.88)
	2HT	0.08 (0.07-0.10)
	SIPH	0.04 (0.03-0.05)
	Cauda	0.09 (0.08-0.10)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	3
	Ant.II	3 (2-3)
	Ant.III	5 (5-6)
	Ant.VIb	1
	URS (accessory setae)	5
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	8 (8-9)
	Each lobe of anal plate	6 (5-7)
No. of rhinaria on	Ant.III	13 (11-15)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.81 (0.74-0.88)
	PT / Ant.VIb	0.90 (0.73-1.20)
	PT / Ant.III	0.26 (0.22-0.30)
	URS / 2HT	1.25 (1.11-1.38)
	URS / Ant.VIb	0.83 (0.71-0.92)
	SIPH / Body length	0.02 (0.02-0.03)
	SIPH / Ant.III	0.08 (0.06-0.10)
	SIPH / HFM	0.08 (0.07-0.10)
	SIPH / Cauda	0.39 (0.33-0.50)
	Setae on Ant.III / BDAnt.III	0.40 (0.33-0.50)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S77. Biometric data of *Tinocallis* (*T*.) *latifoliae* Lee, sp. nov. from Korea

	Body parts	Alate viviparous female (n=12)
Length (mm)	Body length	1.35 (1.19-1.47)
	Whole Antennae	1.32 (1.13-1.55)
	Ant.I	0.06 (0.05-0.07)
	Ant.II	0.05 (0.04-0.06)
	Ant.III	0.46 (0.35-0.58)
	Ant.IV	0.24 (0.20-0.30)
	Ant.V	0.22 (0.19-0.28)
	Ant.VIb	0.15 (0.12-0.19)
	PT	0.09 (0.07-0.11)
	URS	0.08 (0.07-0.08)
	HFM	0.37 (0.32-0.47)
	HTB	0.60 (0.47-0.77)
	2HT	0.09 (0.07-0.10)
	SIPH	0.03 (0.02-0.03)
	Cauda	0.10 (0.09-0.10)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	3
	Ant.II	2 (2-3)
	Ant.III	10 (8-11)
	Ant.VIb	1
	URS (accessory setae)	5 (4-5)
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	8 (7-10)
	Each lobe of anal plate	8 (7-9)
No. of rhinaria on	Ant.III	23 (16-26)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.95 (0.86-1.13)
	PT / Ant.VIb	0.65 (0.53-0.83)
	PT / Ant.III	0.21 (0.16-0.24)
	URS / 2HT	0.89 (0.78-1.00)
	URS / Ant.VIb	0.53 (0.37-0.67)
	SIPH / Body length	0.02 (0.01-0.03)
	SIPH / Ant.III	0.06 (0.04-0.09)
	SIPH / HFM	0.07 (0.06-0.09)
	SIPH / Cauda	0.28 (0.20-0.33)
	Setae on Ant.III / BDAnt.III	0.50

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S78. Biometric data of *Tinocallis* (*T*.) *mushensis* (Takahashi) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.73 (1.59-1.96)
	Whole Antennae	1.41 (1.29-1.50)
	Ant.I	0.07 (0.06-0.09)
	Ant.II	0.06 (0.06-0.07)
	Ant.III	0.58 (0.50-0.63)
	Ant.IV	0.23 (0.20-0.25)
	Ant.V	0.22 (0.18-0.24)
	Ant.VIb	0.14 (0.12-0.16)
	PT	0.11 (0.10-0.13)
	URS	0.12 (0.11-0.14)
	HFM	0.39 (0.34-0.44)
	HTB	0.72 (0.64-0.84)
	2HT	0.08 (0.08-0.09)
	SIPH	0.04 (0.03-0.06)
	Cauda	0.10 (0.09-0.11)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	4 (2-6)
	Ant.II	3 (2-5)
	Ant.III	6 (5-7)
	Ant.VIb	1
	URS (accessory setae)	8 (7-8)
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	11 (10-12)
	Each lobe of anal plate	6 (5-7)
No. of rhinaria on	Ant.III	27 (24-30)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.81 (0.76-0.90)
	PT / Ant.VIb	0.84 (0.67-1.00)
	PT / Ant.III	0.20 (0.17-0.22)
	URS / 2HT	1.45 (1.22-1.63)
	URS / Ant.VIb	0.92 (0.85-1.00)
	SIPH / Body length	0.03 (0.02-0.04)
	SIPH / Ant.III	0.08 (0.05-0.12)
	SIPH / HFM	0.12 (0.09-0.16)
	SIPH / Cauda	0.51 (0.30-0.67)
	Setae on Ant.III / BDAnt.III	0.33

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S79. Biometric data of *Tinocallis* (*T.*) *ulmiparvifoliae* Matsumura from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.31 (2.06-2.52)
	Whole Antennae	1.79 (1.60-1.93)
	Ant.I	0.08 (0.08-0.09)
	Ant.II	0.06 (0.06-0.07)
	Ant.III	0.62 (0.51-0.72)
	Ant.IV	0.33 (0.31-0.38)
	Ant.V	0.33 (0.30-0.36)
	Ant.VIb	0.20 (0.18-0.22)
	PT	0.16 (0.15-0.18)
	URS	0.08 (0.08-0.09)
	HFM	0.54 (0.49-0.59)
	HTB	0.94 (0.86-1.01)
	2HT	0.11 (0.10-0.11)
	SIPH	0.06 (0.04-0.08)
	Cauda	0.16 (0.15-0.17)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	3 (2-3)
	Ant.II	2 (2-3)
	Ant.III	11 (8-14)
	Ant.VIb	1
	URS (accessory setae)	6 (5-6)
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	15 (13-17)
	Each lobe of anal plate	9 (7-10)
No. of rhinaria on	Ant.III	22 (19-26)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.77 (0.74-0.80)
	PT / Ant.VIb	0.80 (0.73-0.89)
	PT / Ant.III	0.26 (0.22-0.29)
	URS / 2HT	0.77 (0.73-0.82)
	URS / Ant.VIb	0.41 (0.36-0.50)
	SIPH / Body length	0.03 (0.02-0.03)
	SIPH / Ant.III	0.10 (0.09-0.11)
	SIPH / HFM	0.12 (0.10-0.14)
	SIPH / Cauda	0.39 (0.33-0.47)
	Setae on Ant.III / BDAnt.III	0.37 (0.33-0.50)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S80. Biometric data of *Tinocallis* (*T.*) *viridis* (Takahashi) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	2.17 (1.85-2.49)
	Whole Antennae	1.90 (1.76-2.07)
	Ant.I	0.08 (0.05-0.10)
	Ant.II	0.07 (0.05-0.09)
	Ant.III	0.65 (0.57-0.73)
	Ant.IV	0.36 (0.26-0.41)
	Ant.V	0.36 (0.26-0.42)
	Ant.VIb	0.21 (0.19-0.24)
	PT	0.14 (0.13-0.16)
	URS	0.11 (0.10-0.12)
	HFM	0.52 (0.45-0.59)
	HTB	0.92 (0.80-1.04)
	2HT	0.10 (0.09-0.11)
	SIPH	0.10 (0.06-0.11)
	Cauda	0.16 (0.13-0.17)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	3 (2-4)
	Ant.II	2 (2-4)
	Ant.III	19 (16-23)
	Ant.VIb	1
	URS (accessory setae)	8 (6-10)
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	7 (6-9)
	Each lobe of anal plate	7 (7-8)
No. of rhinaria on	Ant.III	13 (10-16)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.90 (0.79-1.02)
	PT / Ant.VIb	0.66 (0.54-0.73)
	PT / Ant.III	0.21 (0.19-0.24)
	URS / 2HT	1.10 (1.00-1.22)
	URS / Ant.VIb	0.52 (0.43-0.60)
	SIPH / Body length	0.05 (0.03-0.06)
	SIPH / Ant.III	0.15 (0.10-0.17)
	SIPH / HFM	0.19 (0.13-0.22)
	SIPH / Cauda	0.64 (0.41-0.79)
	Setae on Ant.III / BDAnt.III	0.33

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S81. Biometric data of *Tinocallis* (*T.*) *zelkowae* (Takahashi) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.91 (1.63-2.47)
	Whole Antennae	1.28 (1.09-1.42)
	Ant.I	0.07 (0.06-0.08)
	Ant.II	0.06 (0.05-0.08)
	Ant.III	0.46 (0.36-0.51)
	Ant.IV	0.24 (0.20-0.27)
	Ant.V	0.22 (0.17-0.27)
	Ant.VIb	0.14 (0.13-0.17)
	PT	0.08 (0.07-0.10)
	URS	0.09 (0.08-0.13)
	HFM	0.46 (0.38-0.53)
	HTB	0.73 (0.56-0.91)
	2HT	0.09 (0.07-0.11)
	SIPH	0.04 (0.03-0.05)
	Cauda	0.12 (0.10-0.14)
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	2
	Ant.II	2 (2-3)
	Ant.III	10 (8-11)
	Ant.VIb	1
	URS (accessory setae)	5 (4-6)
	SIPH	0
	8th abdominal tergite	2
	Cauda knob	9 (8-10)
	Each lobe of anal plate	6 (6-7)
No. of rhinaria on	Ant.III	21 (16-23)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.68 (0.53-0.79)
	PT / Ant.VIb	0.56 (0.47-0.71)
	PT / Ant.III	0.18 (0.14-0.21)
	URS / 2HT	1.01 (0.80-1.20)
	URS / Ant.VIb	0.64 (0.47-1.00)
	SIPH / Body length	0.02
	SIPH / Ant.III	0.08 (0.08-0.10)
	SIPH / HFM	0.09 (0.08-0.10)
	SIPH / Cauda	0.32 (0.29-0.40)
	Setae on Ant.III / BDAnt.III	0.39 (0.33-0.50)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S82. Biometric data of *Diphyllaphis* (*D.*) *konarae* (Shinji) from Korea

	Body parts	Apterous viviparous female (n=9)
Length (mm)	Body length	1.39 (1.03-1.59)
	Whole Antennae	0.48 (0.40-0.54)
	Ant.I	0.04 (0.04-0.05)
	Ant.II	0.07 (0.06-0.07)
	Ant.III	0.08 (0.05-0.10)
	Ant.IV	0.07 (0.05-0.08)
	Ant.V	0.08 (0.07-0.09)
	Ant.VIb	0.11 (0.10-0.12)
	PT	0.03 (0.02-0.03)
	URS	0.11 (0.07-0.14)
	HFM	0.25 (0.19-0.30)
	HTB	0.33 (0.25-0.37)
	2HT	0.10 (0.08-0.11)
	SIPH	0.01
	Cauda	0.04
	Longest setae on Ant.III	0.01
No. of setae on	Ant.I	3 (3-4)
	Ant.II	5 (4-7)
	Ant.III	2
	Ant.VIb	2
	URS (accessory setae)	2
	SIPH	0
	8th abdominal tergite	4
	Cauda knob	2 (2-3)
	Each lobe of anal plate	4
No. of rhinaria on	Ant.III	0
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.35 (0.31-0.39)
	PT / Ant.VIb	0.24 (0.17-0.30)
	PT / Ant.III	0.38 (0.25-0.60)
	URS / 2HT	1.11 (0.88-1.27)
	URS / Ant.VIb	0.98 (0.70-1.17)
	SIPH / Body length	0.01
	SIPH / Ant.III	0.14 (0.10-0.20)
	SIPH / HFM	0.04 (0.03-0.05)
	SIPH / Cauda	0.25
	Setae on Ant.III / BDAnt.III	0.50

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S83. Biometric data of *Diphyllaphis* (*N.*) *quercus* (Takahashi) from Korea

	Body parts	Alate viviparous female (n=20)
Length (mm)	Body length	1.69 (1.47-2.37)
	Whole Antennae	0.91 (0.83-1.01)
	Ant.I	0.07 (0.07-0.08)
	Ant.II	0.15 (0.13-0.17)
	Ant.III	0.18 (0.16-0.21)
	Ant.IV	0.14 (0.13-0.16)
	Ant.V	0.15 (0.14-0.17)
	Ant.VIb	0.17 (0.16-0.18)
	PT	0.04 (0.04-0.05)
	URS	0.09 (0.09-0.10)
	HFM	0.36 (0.34-0.41)
	HTB	0.53 (0.49-0.63)
	2HT	0.14 (0.13-0.15)
	SIPH	0.01
	Cauda	0.05 (0.04-0.06)
	Longest setae on Ant.III	0.03 (0.02-0.03)
No. of setae on	Ant.I	5 (3-7)
	Ant.II	9 (7-10)
	Ant.III	9 (7-11)
	Ant.VIb	2
	URS (accessory setae)	2
	SIPH	0
	8th abdominal tergite	4
	Cauda knob	2 (2-4)
	Each lobe of anal plate	4
No. of rhinaria on	Ant.III	0
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.55 (0.43-0.61)
	PT / Ant.VIb	0.25 (0.22-0.31)
	PT / Ant.III	1.77 (1.67-1.80)
	URS / 2HT	0.68 (0.64-0.69)
	URS / Ant.VIb	0.55 (0.53-0.56)
	SIPH / Body length	0.01
	SIPH / Ant.III	0.06 (0.05-0.06)
	SIPH / HFM	0.03 (0.02-0.03)
	SIPH / Cauda	0.20 (0.17-0.25)
	Setae on Ant.III / BDAnt.III	0.87 (0.67-1.00)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S84. Biometric data of *Machilaphis machili* Takahashi from Korea

	Body parts	Apterous viviparous female (n=14)
Length (mm)	Body length	2.05 (1.95-2.12)
	Whole Antennae	1.31 (1.21-1.38)
	Ant.I	0.10 (0.09-0.11)
	Ant.II	0.13 (0.12-0.15)
	Ant.III	0.40 (0.38-0.41)
	Ant.IV	0.24 (0.21-0.26)
	Ant.V	0.24 (0.23-0.25)
	Ant.VIb	0.20 (0.18-0.21)
	PT	0.04 (0.03-0.04)
	URS	0.11 (0.11-0.12)
	HFM	0.54 (0.51-0.59)
	HTB	0.76 (0.73-0.79)
	2HT	0.15 (0.14-0.16)
	SIPH	0.01
	Cauda	0.10 (0.08-0.11)
	Longest setae on Ant.III	0.02 (0.02-0.03)
No. of setae on	Ant.I	5 (4-6)
	Ant.II	8 (6-9)
	Ant.III	17 (13-19)
	Ant.VIb	9 (7-10)
	URS (accessory setae)	7 (5-8)
	SIPH	0
	8th abdominal tergite	6 (5-6)
	Cauda knob	6 (4-7)
	Each lobe of anal plate	3 (3-4)
No. of rhinaria on	Ant.III	0
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.64 (0.59-0.66)
	PT / Ant.VIb	0.18 (0.14-0.22)
	PT / Ant.III	0.09 (0.08-0.11)
	URS / 2HT	0.75 (0.73-0.79)
	URS / Ant.VIb	0.58 (0.52-0.63)
	SIPH / Body length	0.01
	SIPH / Ant.III	0.03 (0.02-0.03)
	SIPH / HFM	0.02
	SIPH / Cauda	0.11 (0.10-0.13)
	Setae on Ant.III / BDAnt.III	0.75 (0.67-1.00)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S85. Biometric data of *Phyllaphis fagifoliae* Takahashi from Korea

	Body parts	Apterous viviparous female (n=7)
Length (mm)	Body length	1.28 (1.24-1.33)
	Whole Antennae	0.77 (0.70-0.86)
	Ant.I	0.06 (0.06-0.07)
	Ant.II	0.10 (0.09-0.12)
	Ant.III	0.17 (0.15-0.19)
	Ant.IV	0.12 (0.10-0.15)
	Ant.V	0.14 (0.13-0.15)
	Ant.VIb	0.13 (0.12-0.14)
	PT	0.04
	URS	0.08 (0.07-0.08)
	HFM	0.29 (0.27-0.31)
	HTB	0.38 (0.35-0.45)
	2HT	0.11 (0.11-0.12)
	SIPH	0.01
	Cauda	0.07 (0.06-0.09)
	Longest setae on Ant.III	0.02 (0.02-0.03)
No. of setae on	Ant.I	7 (6-8)
	Ant.II	9 (8-10)
	Ant.III	10 (9-11)
	Ant.VIb	3
	URS (accessory setae)	4 (4-5)
	SIPH	0
	8th abdominal tergite	6
	Cauda knob	5
	Each lobe of anal plate	5 (4-6)
No. of rhinaria on	Ant.III	0
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.60 (0.56-0.67)
	PT / Ant.VIb	0.31 (0.29-0.33)
	PT / Ant.III	0.24 (0.21-0.27)
	URS / 2HT	0.68 (0.64-0.73)
	URS / Ant.VIb	0.59 (0.54-0.67)
	SIPH / Body length	0.01
	SIPH / Ant.III	0.06 (0.05-0.07)
	SIPH / HFM	0.03 (0.03-0.04)
	SIPH / Cauda	0.14 (0.11-0.17)
	Setae on Ant.III / BDAnt.III	1.17 (1.00-1.50-)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S86. Biometric data of *Saltusaphis tuberculata* Quednau & Lee from Korea

	Body parts	Alate viviparous female (n=3)
Length (mm)	Body length	2.47 (2.40-2.52)
	Whole Antennae	2.49 (2.42-2.53)
	Ant.I	0.15 (0.14-0.15)
	Ant.II	0.10 (0.09-0.10)
	Ant.III	0.80 (0.76-0.83)
	Ant.IV	0.48 (0.46-0.49)
	Ant.V	0.44 (0.42-0.46)
	Ant.VIb	0.21 (0.20-0.22)
	PT	0.32 (0.31-0.33)
	URS	0.07
	HFM	0.49 (0.47-0.50)
	HTB	0.83 (0.81-0.85)
	2HT	0.16 (0.16-0.17)
	SIPH	0.09
	Cauda	0.17 (0.16-0.18)
	Longest setae on Ant.III	0.02
No. of setae on	Ant.I	6
	Ant.II	5 (4-6)
	Ant.III	36 (33-38)
	Ant.VIb	1
	URS (accessory setae)	2
	SIPH	2 (2-3)
	8th abdominal tergite	21 (21-23)
	Cauda knob	18 (16-20)
	Each lobe of anal plate	7 (6-9)
No. of rhinaria on	Ant.III	20 (15-22)
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	1.01 (1.00-1.01)
	PT / Ant.VIb	1.53 (1.45-1.65)
	PT / Ant.III	0.40 (0.37-0.43)
	URS / 2HT	0.43 (0.41-0.44)
	URS / Ant.VIb	0.33 (0.32-0.35)
	SIPH / Body length	0.04
	SIPH / Ant.III	0.11 (011-0.12)
	SIPH / HFM	0.19 (0.18-0.19)
	SIPH / Cauda	0.53 (0.50-0.56)
	Setae on Ant.III / BDAnt.III	0.43 (0.40-0.50)

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S87. Biometric data of *Allaphis ossiannilssonia* (Hille Ris Lambers) from Korea

	Body parts	Apterous viviparous female (n=6)	Alate viviparous female (n=3)
Length (mm)	Body length	2.15 (2.09-2.19)	1.73 (1.70-1.75)
	Whole Antennae	0.75 (0.72-0.78)	0.87 (0.83-0.93)
	Ant.I	0.07	0.07
	Ant.II	0.07 (0.06-0.07)	0.07 (0.06-0.07)
	Ant.III	0.19 (0.18-0.20)	0.25 (0.24-0.26)
	Ant.IV	0.10 (0.09-0.11)	0.14 (0.13-0.15)
	Ant.V	0.13 (0.12-0.13)	0.14 (0.13-0.16)
	Ant.VIb	0.14	0.14 (0.13-0.16)
	PT	0.06 (0.05-0.07)	0.06 (0.05-0.06)
	URS	0.06	0.06 (0.05-0.06)
	HFM	0.31 (0.30-0.31)	0.31 (0.31-0.32
	HTB	0.42 (0.40-0.45)	0.48 (0.46-0.49)
	2HT	0.12 (0.12-0.13)	0.12 (0.11-0.12)
	SIPH	0.01	0.01
	Cauda	0.08 (0.06-0.09)	0.07
	Longest setae on Ant.III	0.02	0.02
No. of setae on	Ant.I	3 (2-4)	4 (3-4)
	Ant.II	5 (4-6)	5 (4-7)
	Ant.III	8 (7-8)	8 (6-10)
	Ant.VIb	3 (2-3)	4 (3-4)
	URS (accessory setae)	2	2
	SIPH	0	0
	8th abdominal tergite	14 (12-17)	12 (11-14)
	Cauda knob	10 (8-12)	12 (11-13)
	Anal plate	6 (6-7)	8 (7-9)
No. of rhinaria on	Ant.III	0 (0-1)	8 (7-9)
	Ant. IV	0	1 (1-2)
	Ant. V	1	1
Ratio (times)	Antennae / Body length	0.35 (0.33-0.37)	0.50 (0.47-0.53)
	PT / Ant.VIb	0.41 (0.36-0.37)	0.41 (0.38-0.46)
	PT / Ant.III	0.31 (0.28-0.37)	0.23 (0.21-0.24)
	URS / 2HT	1.20	1.33 (1.00-1.50)
	URS / Ant.VIb	0.43 (0.46-0.50)	0.41 (0.38-0.46)
	SIPH / Body length	0.01	0..01
	SIPH / Ant.III	0.05 (0.05-0.06)	0.04
	SIPH / HFM	0.03	0.03
	SIPH / Cauda	0.13 (0.11-0.17)	0.14
	Setae on Ant.III / BDAnt.III	0.94 (0.75-1.00)	1.00

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S88. Biometric data of *Subsaltusaphis virginica* from Korea

	Body parts	Apterous viviparous female (n=1)	Alate viviparous female (n=3)
Length (mm)	Body length	2.43	2.10 (1.97-2.23)
	Whole Antennae	1.85	1.21 (1.20-1.21)
	Ant.I	0.09	0.09 (0.08-0.09)
	Ant.II	0.07	0.07
	Ant.III	0.53	0.37
	Ant.IV	0.37	0.23
	Ant.V	0.35	0.19
	Ant.VIb	0.25	0.15
	PT	0.19	0.11
	URS	0.05	0.06 (0.05-0.07)
	HFM	0.46	0.39
	HTB	0.72	0.66 (0.60-0.71)
	2HT	0.13	0.13
	SIPH	0.01	0.01
	Cauda	0.12	0.10 (0.09-0.10)
	Longest setae on Ant.III	0.01	0.01
No. of setae on	Ant.I	2	4
	Ant.II	6	5
	Ant.III	18	15 (13-15)
	Ant.VIb	5	3 (3-4)
	URS (accessory setae)	2	2
	SIPH	0	0
	8th abdominal tergite	8	11 (8-13)
	Cauda knob	12	13 (12-14)
	Anal plate	10	7 (6-8)
No. of rhinaria on	Ant.III	0	8
	Ant. IV	0	0
	Ant. V	1	1
Ratio (times)	Antennae / Body length	0.76	0.58 (0.54-0.61)
	PT / Ant.VIb	0.76	0.73
	PT / Ant.III	0.36	0.30
	URS / 2HT	0.38	0.46 (0.38-0.54)
	URS / Ant.VIb	0.20	0.40 (0.33-0.47)
	SIPH / Body length	0.01	0.01
	SIPH / Ant.III	0.02	0.03
	SIPH / HFM	0.02	0.03
	SIPH / Cauda	0.08	0.11 (0.10-0.11)
	Setae on Ant.III / BDAnt.III	0.33	0.33

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

Table S89. Biometric data of *Thripsaphis ballii caspitosae* Richards from Korea

	Body parts	Apterous viviparous female (n=20)
Length (mm)	Body length	1.73 (1.49-1.89)
	Whole Antennae	0.73 (0.69-0.74)
	Ant.I	0.07 (0.06-0.07)
	Ant.II	0.06 (0.05-0.06)
	Ant.III	0.17 (0.16-0.19)
	Ant.IV	0.11 (0.10-0.12)
	Ant.V	0.13 (0.12-0.13)
	Ant.VIb	0.12 (0.10-0.14)
	PT	0.07 (0.06-0.07)
	URS	0.05 (0.05-0.06)
	HFM	0.25 (0.23-0.26)
	HTB	0.34 (0.31-0.37)
	2HT	0.10 (0.10-0.11)
	SIPH	0.01 (0.01-0.02)
	Cauda	0.08 (0.07-0.09)
	Longest setae on Ant.III	0.02
No. of setae on	Ant.I	4 (3-4)
	Ant.II	5 (5-6)
	Ant.III	12 (10-13)
	Ant.VIb	4
	URS (accessory setae)	2
	SIPH	0
	8th abdominal tergite	19 (16-21)
	Cauda knob	11 (10-12)
	Each lobe of anal plate	6 (5-7)
No. of rhinaria on	Ant.III	0
	Ant. IV	0
	Ant. V	1
Ratio (times)	Antennae / Body length	0.42 (0.39-0.50)
	PT / Ant.VIb	0.56 (0.50-0.70)
	PT / Ant.III	0.39 (0.33-0.44)
	URS / 2HT	0.53 (0.50-0.60)
	URS / Ant.VIb	0.45 (0.38-0.50)
	SIPH / Body length	0.01
	SIPH / Ant.III	0.08 (0.05-0.12)
	SIPH / HFM	0.06 (0.04-0.08)
	SIPH / Cauda	0.17 (0.11-0.25)
	Setae on Ant.III / BDAnt.III	1.00

Abbreviations are explained in materials and methods; a blank cell in the range means that all measurements were identical.

국문 초록

한반도산 참알락진딧물아과(노린재목: 진딧물과)의 계통분류학적 연구

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본 연구는 참알락진딧물아과의 계통분류학적 연구로써, 총 3 가지 주제로 구성되어있다. 첫 번째 연구는 한반도산 참알락진딧물아과의 분류학적 검토, 두 번째는 DNA 바코딩을 기반으로 참알락진딧물아과의 은폐된 종 다양성을 발굴하는 연구, 세 번째는 참알락진딧물아과의 분자계통 및 기주식물 관계를 통해 이들의 진화 양상을 규명하는 연구이다.

첫 번째 연구에서는 한반도산 참알락진딧물아과와 그 근연 아과인 너도밤나무가루진딧물아과, 사초진딧물아과에 속한 총 33 속 89 종에

대한 분류학적 연구를 수행하여 16 신종, 18 미기록종, 1 복원종, 4 오동정종, 2 이명동종을 한반도에서 처음으로 확인했다.

두 번째 연구에서는 115 개 형태종 (Morphospecies)에 대한 899 개의 *COI* 염기서열을 기반으로 참알락진딧물아과 그룹의 은폐된 종 다양성 발굴 연구를 수행하여 총 12 개의 형태종으로부터 15 종의 은폐종을 발굴하였고, 형태적으로는 구분되나 DNA 바코딩을 공유하는 3 쌍의 종 그룹을 규명하였다.

세 번째 연구에서는 분자계통연구를 통해 참알락진딧물아과의 단계통성과 근연 그룹의 규명 및 진화적 관점에서 이들의 기주 관계와 기주 이동을 기반으로 족, 속 등 그 내부 구성원들의 관계 규명을 시도하였다. 그 결과, 너도밤나무가루진딧물아과 및 사초진딧물아과가 참알락진딧물아과에 귀속되어 참알락진딧물아과는 측계통을 형성하는 것이 확인되었다. 또한 참알락진딧물아과는 참나무목을 원시 기주로 분지한 그룹임을 확인 할 수 있었다.

주요어: 너도밤나무가루진딧물아과, 미기록종, 분자계통, 사초진딧물아과, 신종, 은폐종, 진딧물

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